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A Survey of the Poisonous Fishes of the Phoenix Islands[1]

BRUCE W. HALSTEAD AND NORMAN C. BUNKER

THIS paper contains the results of the first of a series of field investigations on the poisonous fish fauna of the tropical Pacific. The purpose of this study is to provide more accurate data regarding the identification of poisonous fishes.

The present investigations in medical ichthyology had their conception about 1946. From 1946 to 1950 the study was restricted to a literature compilation and review. During December, 1950, the senior author made a preliminary survey of Canton Island to determine the availability of refrigeration facilities, logistic support, field conditions and equipment needs. A more intensive field investigation was conducted in the Phoenix and Line Islands during January to April, 1951, by the junior author, his wife Mrs. Jeanne M. Bunker, and Mr. Kenneth E. Groves; however, the major time was spent at Canton. The efforts of our own staff were supplemented by material obtained from the Pacific Oceanic Fishery Investigations, of the U. S. Fish and Wildlife Service, and the Division of Fish and Game of the Territory of Hawaii.

Fishes were collected by various means—hook and line, beach seine, spear, throw net, dip net, and rotenone. Because of the toxicological screening tests, it was necessary to refrigerate all specimens within a short time after their capture. Continual dependence upon refrigeration facilities presented problems which in some instances proved to be insurmountable and valuable collections were lost.

GEOGRAPHY AND ECOLOGY OF THE PHOENIX ISLANDS

The Phoenix Group consists of eight, low-lying, coral islands: Canton (Figs. 1, 2), Enderbury (Fig. 3), Birnie, Phoenix, Sydney (Fig. 4), Hull (Fig. 5), Gardner and McKean (Hydr. Off., 1940: 400–13; Robson 1950: 219–20). They lie in the vicinity of lat. 4°S. and long. 172°W., about 1670 miles southwest of Honolulu. The Phoenix Islands have a total land area of 11.1 square miles (Freeman 1951: 419). The prevailing winds are easterly, and the period of adverse weather is from January to May inclusive. Offshore currents generally set westward, but vary in strength and direction with the wind. Enderbury, Phoenix, Birnie and McKean are uninhabited; the remaining islands of the Phoenix Group have a total human population of about 1200. The Phoenix Islands are administered by the Western Pacific High Commission of the Colonial Office and form a part of the Gilbert and Ellice Colony of Great Britain, with the exception of Canton and Enderbury, which are an Anglo-American condominium. Specimens were not obtained from Birnie, Phoenix, Gardner, and McKean Islands.

REEF BIOCHORE AND COLLECTING STATIONS

The reef biochore of Canton, Enderbury, Hull, and Sydney Islands, from which specimens were obtained, may be divided into the following biotopes:

LAGOON SIDE:

1: *Sand:* Upper shore comprised of variable amounts of coral rubble and sand, the latter predominating near the water's edge. Bottom is sand interspersed with coral reefs, knolls, boulders, and/or gravel patches. Algal growth is minimal or absent in areas of drifting sand. Green filamentous algae were observed growing in abundance in shallow bays on northwest shore of Canton lagoon. Water depth is variable, but seldom exceeds 14 fathoms. Fish population in sandy areas is generally sparse, tending to be more concentrated about coral reefs and knolls. Species most likely to be observed swimming over sandy stretches are: snappers, mullet, pampano, goatfish, lizzardfish and an occasional shark or ray. The lagoons at Sydney and Enderbury are said to be devoid of fishes because of excessive salinity, but limited collecting time did not permit investigation of the matter.
Field numbers include B–51–2, 3, 5, 7, 12, 14, 17, 18, 24, and 26–29; and POFI–50–3, and 6–8.

[1] This investigation was supported by a research grant from the Division of Research Grants and Fellowships, of the National Institutes of Health, Public Health Service, and a contract from the Office of Naval Research, Department of the Navy (Contract No. NONR 205–(00).

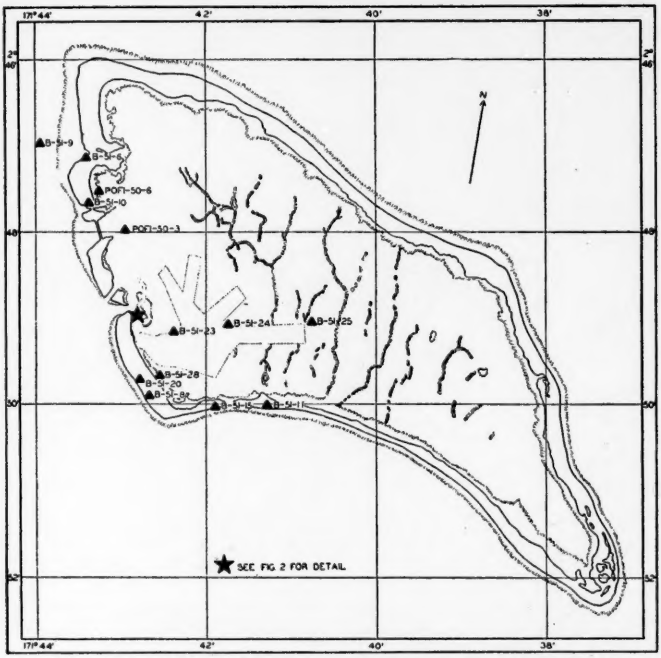

Fig. 1. Canton Island. (Numbers on maps refer to collecting stations.)

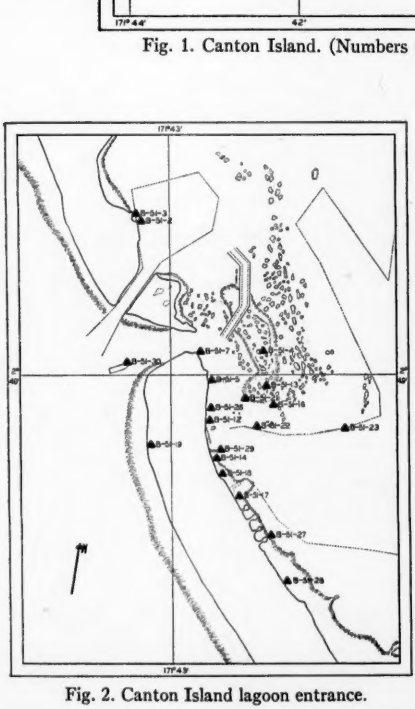

Fig. 2. Canton Island lagoon entrance.

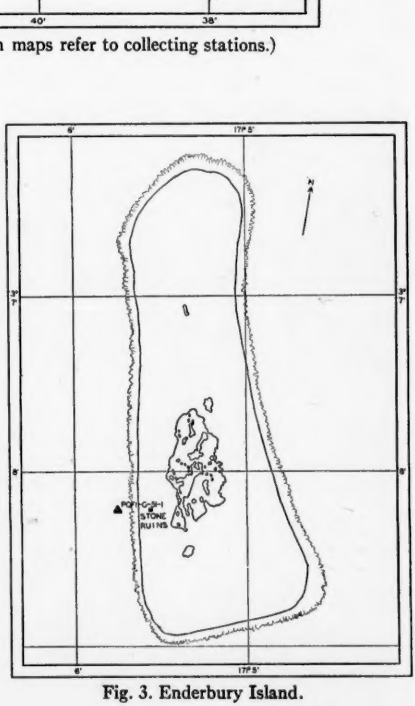

Fig. 3. Enderbury Island.

2: *Coral:* Interspersed throughout the lagoons at Canton and Hull are large reefs of luxurious growths of living corals and isolated coral knolls. The reef providing the best collecting in the Canton lagoon lay near the main channel leading to the ocean. The lagoon fish population is most concentrated and varied in these coral areas. Very few algae were observed growing near the coral. Numerous specimens of *Tridacna* were present but relatively few other molluscs were seen. Inhabitants of the coral biotope consisted of wrasses, eels, and parrot, cornet, scorpion, butterfly, squirrel, damsel, file and surgeon fishes.
Field numbers include B–51–4, 13, 16, 21–23, and 25.

OCEAN SIDE:

1: *Coral:* The coral reefs on the ocean side vary considerably depending upon their exposure to wave shock and wind. In some areas the beaches are cluttered with coral boulders and rubble which may extend down into the water, in others it may be sand or gravel interspersed with clumps of coral. The coral knolls or "heads" which characterize the lagoon are conspicuously absent from the seaward reef at Canton. The rubble-littered regions support a large population of crabs and various species of molluscs. The more common fish species of this habitat are: pampano, grouper, snappers, eels and surgeonfish. Gobies, blennies, damselfish and the smaller coral fishes can be observed hiding in crevices and swimming about the coral.
Field numbers include B–51–10, 19, and 30; and POFI–G–51–1, 3, and 4.

2: *Reef Flat:* Jutting from the seaward shore at irregular intervals are flat-pavement-like outcroppings of limestone. The surfaces of these rocks may be smooth, encrusted with coral, or marked with crevices or shallow tidepools which remain filled with water during low tide. The fishes of this biotope are generally small species such as gobies, blennies, damselfish and eels in the shoal areas, but in the deeper pools or during high tide the larger forms such as groupers, snappers, surgeonfish, etc., may be observed.
Field numbers include B–51–8, 11, 15 and 20.

3: *Tidepools:* Eroded in the limestone rocks along the seaward shore are tidal pools of various sizes, as mentioned above. Since the inhabitants of these pools are generally smaller fishes, this habitat was not found to be very productive in poisonous species.
Field number, B–51–6.

4: *Open-water:* The seaward reef generally extends out from the atoll for only a few hundred yards and then suddenly terminates as the bottom makes a precipitous descent. Inhabiting these offshore waters, without the protection of the reef, are such species as tuna, wahoo, barracuda, pampano and sharks.
Field number, B–51–9.

EPIDEMIOLOGICAL DATA

With the exception of the statement in *Sailing Directions for the Pacific Islands* (Hydr.

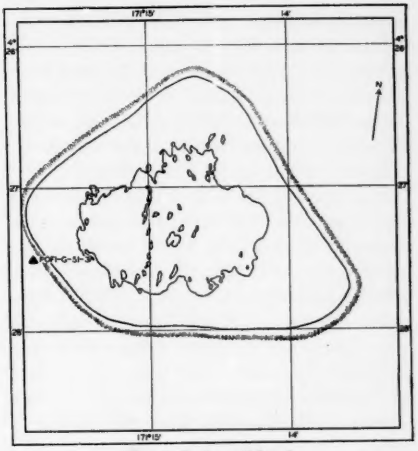

Fig. 4. Sydney Island.

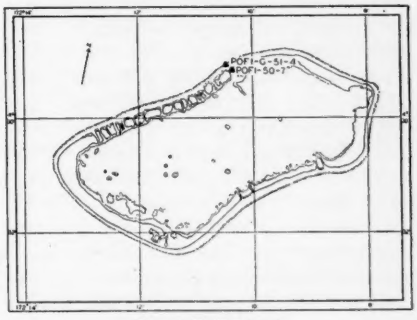

Fig. 5. Hull Island.

Off., 1940: 402) regarding the possible toxic qualities of red snapper (*Lutjanus spp.*) and rock cod (*Epinephelus spp.*) taken in Canton lagoon, we have been unable to locate any published reference on ichthyosarcotoxism at this island. The incidence of fish poisoning is low, in spite of the fact that this is supposedly an endemic area. This situation may be attributed to the restricted fish diet of the European population; this diet consists largely of the better known food fishes, pampano (*Caranx*), mullet (*Mugil*), barracuda (*Sphyraena*), wahoo (*Acanthocybium solandri*), tunas (*Thunnidae*), etc., and to the fact that the natives are careful to discard all questionable species. However, in spite of these precautions, poisonings occasionally occur. On May 7, 1951, two Gilbertese natives were mildly intoxicated as a result of

ingesting the flesh from a 75-pound parrotfish (*Scarus sp.*). The fish was captured in the ocean, opposite the lagoon entrance in the vicinity of the wrecked SS PRESIDENT TAYLOR, in about 7 fathoms of water, on May 5, 1951. Two months prior to this experience, one of the natives was poisoned from eating a "spotted blue rock cod" (probably *Cephalopholis argus* Bloch and Schneider). The fish was said to have weighed about 15 pounds and was captured in the channel in the lagoon, opposite the North Side Wharf.

ENDERBURY ISLAND.—Fishes are abundant in this region and all common species are said to be edible (Hyd. Off., 1940: 404). The validity of this latter statement remains to be demonstrated, since material from this region is grossly inadequate.

HULL ISLAND.—Natives maintained that poisonous fishes inhabit the west, leeward side of the island and believe that they are more concentrated in an area ¼ mile on either side of the blasted channel (lat. 4°29′10″S., long. 172°10′23″W.) the "poisonous fish zone." The limited time available for collecting at this island did not permit an investigation of the validity of this statement. Some claim that fishes caught in the lagoon may be poisonous (Hydr. Off., 1940: 490), but native fishermen insisted they were edible. Contradictory statements such as the foregoing impress one of the need for additional study. At any rate, no cases of ichthyosarcotoxism have been reported at Hull Island during the past five years. However, all questionable species are carefully discarded by the natives, especially fishes taken from the "poisonous fish zone."

SYDNEY ISLAND.—According to the natives, the incidence of ichthyosarcotoxism was high, but reliable statistics were not available. Native fishermen stated that the poisonous fishes are restricted to the northwest, leeward side of the island. The livers of some of the sharks in this area are said to be toxic. There are reportedly no fishes in the lagoon because of the excessive salinity of the water.

TAXONOMIC STUDIES

Effort was directed toward obtaining accurate taxonomic diagnoses of all material that was brought into the laboratory. The most recent and comprehensive work concerning the Phoenix Islands' fishes is that of Schultz (1943). The numerous systematic keys that appear in Weber and de Beaufort's "The Fishes of the Indo-Australian Archipelago" (1911–1951) were found to be indispensable. Jordan and Evermann (1905), Jordan and Seale (1906) and the numerous works of Fowler (1928, 1931, 1933, 1934, 1941), and Fowler and Bean (1928, 1929, 1930) provide excellent bibliographies and are well illustrated. The monumental works of Günther (1873–77, 1881, 1909, 1910) and Bleeker (See Weber and de Beaufort, Vol. I, for complete bibliography of Bleeker's papers) contain many useful drawings of tropical Pacific fishes, but are unfortunately difficult to obtain. The profusely illustrated works of Day (1878–88) and Smith (1950) were also found to be helpful.

In dealing with the plectognaths, the nomenclature proposed by Fraser-Brunner (1935, 1941, 1943) was adopted. Our systematic armamentarium was further supplemented by numerous taxonomic keys graciously supplied by Dr. Leonard P. Schultz, U. S. National Museum, from his exhaustive work on fishes of the Marshall Islands (in press). The authors are further indebted to Dr. Schultz for an identified collection of 743 specimens from the Marshall Islands, which proved to be of considerable value as comparative material. All material of questionable identity was sent to Dr. Schultz for final identification.

Representative specimens of all positive and negative material have been catalogued and preserved in the museum of the Department of Ichthyology and Herpetology of the School of Tropical and Preventive Medicine.

METHODS USED IN SCREENING FISHES

TECHNIQUES OF OTHER WORKERS.—A large variety of laboratory animals and techniques have been used by various authors in the testing of poisonous fish extracts. Ishihara (1918: 376–80) used rabbits, guinea pigs, rats, mice, sparrows, doves, chickens, loaches, frogs, toads, eels, snakes, turtles, carp, plaice, sculpin, dragonflies, leaf chafers, and newts. The toxins were administered by various routes, *viz.*, oral, intravenous, subcutaneous, intracutaneous, intracardial, intramuscular, intraperitoneal, subdural, intracranial, intramedullary, anterior chamber of the eye, and conjunctiva. However,

Ishihara was primarily concerned with the pharmacological properties of fugu toxin rather than with screening studies. Most of his extracts were prepared with the use of physiological saline, but in some instances he used the powdered or commercial forms of the poison.

Macht and Spencer (1941: 229–31) tested more than 65 different species of North American fishes for the presence of toxic substance. Tissue extracts were prepared by grinding up samples of fish muscle with an equal weight of sand, and to this mixture was added physiological saline in the proportion of 2 ml. to each gram of muscle. The homogenate was strained through muslin and the filtrate was then tested by injecting 1 to 3 ml. intraperitoneally into white mice weighing from 20 to 25 gm. each. Macht also used a phytopharmacological technique for testing fish toxins which employed the seedlings of *Lupinus albus*. The increment or growth of the single straight root of the seedling was measured after the plant had been grown for 24 hours in the dark at 15°C in the extract to be tested. Growth of the root is then compared with controls which were grown in plant physiological or Shive's solution. The index of growth or phytotoxic index was expressed by the ratio of X/N or average growth in the unknown solution over the growth of the controls.

Sommer and Meyer (1937: 570, 593, 597) in their studies on mussel and fish toxins used acid ethanol, neutral methanol, and methanol acidulated with hydrochloric acid for extrants. Later Hashimoto and Migita (1950: 80) demonstrated that methanol acidulated with hydrochloric acid "produces an artificial poison from some common components of shellfish." They also observed (*ibid.*, 1951: 341–46), with puffer poison, that methanol acidulated with hydrochloric acid destroys puffer toxin. They recommended extraction with the use of methanol and acetic acid. This latter method is said to extract the toxin readily in large quantities and yields results similar to plain water extraction.

The most exhaustive epidemiological study on South Pacific poisonous fishes conducted to date is that of Yoshio Hiyama of Japan. Hiyama (1950: 10, 62) used mice, cats, and puppies for his screening tests, which consisted of both feeding and extraction techniques. For his feeding experiments, weighed samples were taken of muscle, intestine, liver, gonads and blood. Some of the samples were cooked, while others were fed raw. In some instances it was necessary to use salted and dried meat. He tried a number of extraction techniques, but the one giving the most satisfactory results consisted of placing 10 gm. of raw flesh in 200 ml. of absolute alcohol where it was left for 15 hours at room temperature (30 to 32°C). After filtering, 15 ml. of distilled water was added and the solution then heated for about 2 hours until it was concentrated to 2.7 ml. Hiyama found it difficult in cases of mild poisoning to detect the symptoms in mice and also found a great deal of individual variation in their reactions to ingested poisonous flesh. He came to the conclusion that, since the results of the feeding technique were dependent upon the amount of flesh ingested by the animal, the extraction injection method is preferable.

Kawakubo (1942: 30–34) found that man and dog were more susceptible to ichthyosarcotoxins than either the cat or pig, and that the chicken reacted least of all.

TECHNIQUES USED IN THIS STUDY.—In selecting a method to be used in our studies, the following requisites were taken into consideration: (1) The method should be sufficiently sensitive to give positive results; (2) the test should not give false positive results; (3) the test should be as simple as possible and suitable for mass screening purposes; and (4) the test should be economically feasible.

After consultation with a number of investigators, it was decided to use a method suggested by Doctors Karl Meyer and Hermann Sommer of the University of California. The original technique consisted of taking flesh samples from the musculature and, whenever possible, liver and gonads. Two ml. of 0.1 N HCl were added for each gram of flesh. The material was then ground in a mortar or homogenized in a Waring Blendor. The homogenate was boiled slowly for 10 minutes, cooled and centrifuged. One ml. of the supernatant fluid was then taken and injected intraperitoneally into a single 18- to 23-gm. white mouse, California Caviary Strain No. 1 (CC_1). Extract numbers 1 to 129 were prepared in the above mentioned manner.

Extracts with the prefix number over 130 were prepared in the following manner: samples were taken from the musculature, liver,

intestines and gonads. Two ml. of physiological saline were added for each gram of flesh. The material was then homogenized in a Waring Blendor. The homogenate was centrifuged at 2000 r.p.m. for 25 minutes using a head with an 8-inch radius. One ml. of the supernatant fluid was injected intraperitoneally into four white laboratory mice (Strain CC_1), weighing 15 to 25 gm.

DEFINITION OF TERMS FOR TABLE I: NEGATIVE: The test is negative if the mouse continues to remain asymptomatic during the maximum test period of 36 hours.

WEAKLY POSITIVE: The test is weakly positive if the mouse shows definite symptoms such as lacrimation, diarrhea, ruffling of the hair, hypoactivity, etc., but the animal recovers.

MODERATELY POSITIVE: This term is used if the mouse develops ataxia, hypoactivity, and/or paralysis and dies within a period of 1 to 36 hours.

STRONGLY POSITIVE: The test is strongly positive if the mouse develops ataxia, which is usually followed by clonic or tonic convulsions of varying degrees, paradoxical respiration, respiratory paralysis and death occurs within a few seconds to one hour.

The results of the injection experiments are given in Table I (toxic species) and Table II (non-toxic species) and in subsequent paragraphs. Abbreviations are as follows: M = muscle; L = liver; G = gonads; I = intestine; V = viscera (includes all of the abdominal organs); N = negative; W = weakly positive; M = moderately positive; S = strongly positive. Certain material is listed only as "scarid and labrid" because both of these families are now in the process of taxonomic revision. In the groups of species listed in Table II, muscle extracts were tested in all. Additional extracts were prepared from liver, gonads, intestines and viscera as indicated by the superscription appearing in front of the species name.

Our screening techniques were largely developed as a result of trial and error methods. During the initial period of the investigation, refrigeration facilities were at a premium and fishes brought into the laboratory were rapidly screened and then preserved in formalin and alcohol to make room for incoming material. Injection results of muscle extracts were used as a criterion as to whether or not additional tests should be conducted on the gonads, liver, and intestines. Hence, much of the early material was preserved without having tested the viscera. However, the arrival of some *Acanthurus triostegus* from the Department of Health in Honolulu soon revealed the fallacy of using muscle samples as a criterion for further study. The *A. triostegus* were part of a shipment that had been captured at Palmyra, Line Islands, and transported to Maui for sale in the markets. This particular batch of fish had poisoned 24 persons who developed the typical ichthyosarcotoxic syndrome. The specimens sent to us had been taken from the garbage cans, cooking utensils, and refrigerators of the poisoned victims. Muscle extracts were prepared from a number of the fish and all of them proved to be negative by intraperitoneal injections on mice. Tests made of the viscera were found to be positive. Thus it became evident that both muscle and viscera should be tested before the toxicity of a specimen can be determined.

As a result of the foregoing experience a series of tests were conducted in an attempt to develop a more sensitive screening method. Toxic extracts and samples of flesh were tested on cats, chickens, rats, hamsters, mice and crayfish and were administered by oral, subcutaneous, intramuscular, intravenous and intraperitoneal routes. The following conclusions were derived from these studies:

1. The most reliable method is to feed the test material to cats. As this method is not very practical on a mass basis and a modest consumable supply budget, this technic was utilized only as an additional check on all questionable and weakly positive results derived from intraperitoneal mouse injections.

2. Mice are the next most satisfactory, and intraperitoneal injection is the most effective route of administration. Mice are inexpensive and readily available. A minimum of four mice should be used in order to allow for physiological variation. They should be observed for a period of 36 hours if one is to obtain valid results. All dead mice should be autopsied to rule out the possibility of internal hemorrhage from needle trauma. Mouse feeding tests were found to be of little value because of variation in physiological response of individual mice to a given test sample. More-

TABLE I

LIST OF FISHES FOUND TO BE TOXIC

For key to symbols for part of fish used in injection extract, and for symbols under results, see text

Extract No.	Species	Field No.	Part of fish	Results
	CANTON ISLAND			
323-1, 3	*Abudefduf septemfasciatus* (Cuvier)	B-51-12	M, G	N, M
333-1	*A. sordidus* (Forskål)	B-51-12	M	M
287-3, 4	*Acanthurus lineatus* (Linnaeus)	B-51-13	G	"
39-1	*Arothron hispidus* (Linnaeus)	POFI-50-6	M	S
40-1	" " "	POFI-50-6	"	"
41-1	" " "	POFI-50-8	"	"
46-1	" " "	POFI-50-6	"	"
208-1	" " "	B-51-28	"	"
1-1	" " "	POFI-50-6	"	"
LA-1, 2	" " "	POFI-50-8	M, L	"
192-1	*Bothus mancus* (Broussonet)	B-51-2	M	M
405-5	" " "	B-51-12	V	"
332-1	*Chaetodon ephippium* Cuvier	B-51-13	M	W
227-1	*C. unimaculatus* Bloch	B-51-21	"	M
389-1, 5	*Epibulus insidiator* (Pallas)	B-51-16	M, V	N, M
272-1, 2, 4	*Lethrinus miniatus* (Bloch)	B-51-26	M, I; L	N, M
316-1, 3	*L. nebulosus* (Forskål)	B-51-23	M, G	N, W
400-1, 2, 5	*L. ornatus* Cuvier and Valenciennes	B-51-5	L; M, V	N, M
324-1, 3, 4	*L. variegatus* Cuvier and Valenciennes	B-51-5	M; G, I	M, N
398-1, 2, 3, 4	" " " "	B-51-5	M, L, G; I	N, M
229-1	*Mulloidichthys samoensis* (Günther)	B-51-7	M	M
177-1, 2, 3, 4	*Pseudobalistes flavomarginatus* (Rüppell)	B-51-6	M, L; G, I	N, M
245-1	*Pseudoscarus* sp.	Gift	M	W
401-1, 5	*Rhinecanthus aculeatus* (Linnaeus)	B-51-12	M, V	N, M
271-2, 3	*Scarid*	B-51-17	L, G	N, M
271-1, 2, 3	*Scarus dussumieri* Valenciennes	B-51-17	G; M, L	M, N
375-1, 5	*Scarus jonesi* (Streets)	B-51-13	M, V	M, N
404-1, 5*	*Scarus* sp. ?	B-51-12	M, V	N, M
107-1	*Scaurs sordidus* Forskål	B-51-4	M	W
	ENDERBURY ISLAND			
143-1, 2, 4	*Caranx lugubris* Poey	POFI-G-51-1	L; M, I	M, N
356-1, 2, 4	*C. melampygus* Cuvier	POFI-G-51-1	M, I; L	N, M
337-1, 2, 3, 4	*C. sexfasciatus* Quoy and Gaimard	POFI-G-51-1	M, G, I; L	N, M
131-1	*Lutjanus bohar* (Forskål)	POFI-G-51-1	M	W
	HULL ISLAND			
331-1, 5	*Acanthurus fulginosus* Lesson	POFI-G-51-4	M, V	N, M
26-1, 2	*Arothron meleagris* (Lacépède)	POFI-50-7	M, L	S
6-1, 2	*A. nigropunctatus* (Bloch)	POFI-50-7	"	"
35-1	*Leiuranus semicinctus* (Lay and Hull)	POFI-50-7	M	"
2-1, 2, 3	*Lutjanus vaigiensis* (Quoy and Gaimard)	POFI-50-7	M; L, G	N, W
	SYDNEY ISLAND			
345-1, 4	*Lutjanus bohar* (Forskål)	POFI-G-51-1	M	W

* This species is being studied by Dr. Leonard P. Schultz.

TABLE II

LIST OF FISHES FOUND TO BE NON-TOXIC

All species tested by muscle extract, and in addition certain species tested by extracts of liver (superscript L), intestine (I), viscera (V), and/or gonad (G).

CANTON ISLAND

Abudefduf sordidus (Forskål), B-51-12
L*Acanthurus fulginosus* Lesson, B-51-10, POFI-50-6, POFI-50-8
A. glaucopareius (Bloch), B-51-4, B-51-21, B-51-13
A. lineatus (Linnaeus), B-51-13
A. mata Russell, POFI-50-3
A. triostegus (Linnaeus), B-51-12
L*Albula vulpes* (Linnaeus), POFI-50-8, B-51-8
Alutera scripta (Osbeck), B-51-2
Anyperodon leucogrammicus (Cuvier), B-51-13
L*Arothron hispidus* (Linnaeus), B-51-4, POFI-50-8
Bothus mancus (Broussonet), B-51-12
Carangoides ferdau jordani (Nichols), B-51-10
LI*Caranx melampygus* Cuvier, B-51-10, B-51-11, B-51-8
Cephalopholis alboma rginatus Fowler, B-51-13
C. argus (Bloch), B-51-23, B-51-3
L*Chaetodon auriga* Forskål, B-51-12, B-51-18
C. bennetti Cuvier, B-51-13
C. ephippium Cuvier, B-51-13
C. lunula (Lacépède), B-51-21
C. ornatissimus Cuvier and Valenciennes, B-51-21
C. trifasciatus Mungo Park, B-51-13
I*Ctenochaetus strigosus* (Bennett), B-51-13, B-51-4
Diodon hystrix Linnaeus, POFI-50-3
Echidna nebulosa (Ahl), B-51-20
V*Epibulus insidiator* (Pallas), B-51-21
Epinephelus fuscoguttatus (Forskål), B-51-5, B-51-13
E. macrospilos Schultz, POFI-50-8, B-51-2
V*E. melanostigma* Schultz, B-51-3, B-51-5
E. merra Bloch, POFI-50-3
I*E. areolatus* Borodin, B-51-2
E. summana (Forskål), B-51-13
Fistularia petimba Lacépède, B-51-4
V*Gerres oblongus* Cuvier, B-51-12
Gnathodentex aurolineatus (Lacépède), B-51-5
Gymnothorax javanicus (Bleeker), B-51-2
G. pictus (Ahl), B-51-12
G. undulatus, (Lacépède), POFI-50-3
Heniochus acuminatus (Linnaeus), B-51-4
H. permutatus Cuvier, B-51-21
H. varius (Cuvier), 5-51-21
LI*Holocentrus spinifer* (Forskål), POFI-50-3, B-51-13, B-51-4
Labrid, POFI-50-3
Lethrinus nebulosus (Forskäl), B-51-13, B-51-23
LGV*L. ornatus* Cuvier and Valenciennes, B-51-17, B-51-5
LGI*L. variegatus* Cuvier and Valenciennes, B-51-5
LGI*Lutjanus gibbus* (Forskål), B-51-5, B-51-2, POFI-50-8, B-51-7
V*L. kasmira* (Forskål), B-51-5
LI*L. monostigma* (Cuvier), B-51-5
V*L. vaigiensis* (Quoy and Gaimard), POFI-50-8, B-51-3, B-51-7
Monotaxis grandoculis (Forskål), B-51-5, B-51-21, POFI-50-3
Mugil vaigiensis Quoy and Gaimard, B-51-2
Mulloidichthys samoensis (Günther), B-51-12, B-51-15
Myripristis murdjan (Forskål), B-51-13, B-51-4
Parupeneus barberinus (Lacépède), B-51-12, B-51-18
Pygoplites diacanthus (Boddaert), B-51-13
LG*Rhinecanthus aculeatus* (Linnaeus), POFI-50-3, B-51-15, B-51-12, POFI-50-6
Scarus dussumieri Valenciennes, B-51-17
Scarus microrhinus Bleeker, B-51-13
Scarus pectoralis Valenciennes, B-51-13
Scarus sordidus Forskål, B-51-3, B-51-13
Scarus sp.?, B-51-2
Scarus vermiculatus (Fowler & Bean), B-51-13
Scomberoides sanctipetri (Cuvier), B-51-2
LGI*Scorpaenopsis gibbosus* (Bloch), B-51-12, B-51-7
Sphyraena jello Cuvier and Valenciennes, B-51-9
S. picuda Bloch and Schneider, B-51-9
Trachinotus bailloni (Lacépède), B-51-12
GI*Variola louti* (Forskål), B-51-7

HULL ISLAND

Abudefduf septemfasciatus (Cuvier), POFI-50-7
Acanthurus triostegus (Linnaeus), POFI-50-7
Belone platyura Bennett, POFI-G-51-4
Bothus pantherinus (Rüppell), POFI-50-7
Callyodon bataviensis (Bleeker), POFI-50-7
Chaetodon lunula (Lacépède), POFI-50-7
C. setifer Bloch, POFI-50-7
LG*Conger cinereus* Rüppell, POFI-50-7
IL*Ctenochaetus strigosus* (Bennett), POFI-G-51-4
V*Cypselurus atrisignis* Jenkins, POFI-G-51-4
C. brevis Weber and de Beaufort, POFI-G-51-4
Epinephelis merra Bloch, POFI-50-7
E. summana (Forskål), POFI-G-51-4
Halichoeres trimaculatus (Quoy and Gaimard), POFI-50-7
V*Hemiramphus marginatus* (Forskål), POFI-G-51-4
Holocentrus sammara (Forskål), POFI-50-7
I*Lutjanus bohar* (Forskål), POFI-G-51-4
Mulloidichthys samoensis (Günther), POFI-50-7
Neomyxis sclateri Steindachner, POFI-50-7
Pomacentrus lividus (Bloch), POFI-50-7
Rhinecanthus aculeatus (Linnaeus), POFI-50-7
Scarus forsteri Valenciennes, POFI-50-7
Stethojulis albovittata (Bonnaterre), POFI-50-7
S. axillaris (Quoy and Gaimard), POFI-50-7
G*Variola louti* (Forskål), POFI-G-51-4

JARVIS ISLAND

**Scarus* sp. ?, POFI-G-51-5

SIDNEY ISLAND

LI*Acanthurus guttatus* Bloch, POFI-G-51-3
A. lineatus (Linnaeus), POFI-G-51-3
Caranx lugubris Poey, POFI-G-51-3
V*C. sexfasciatus* Quoy and Gaimard, POFI-G-51-3
I*Cephalopholis miniatus* (Forskål), POFI-G-51-3
Lutjanus kasmira (Forskål), POFI-G-51-3
L*Rhinecanthus rectangulus* (Bloch and Schneider), POFI-G-51-3
I*Variola louti* (Forskål), POFI-G-51-3

ENDERBURY ISLAND

Cypselurus atrisignis Jenkins, POFI-G-51-1
C. bahiensis (Ranzani), POFI-G-51-1
Kuhlia sandvicensis (Steindachner), POFI-G-51-1

* This species is being studied by Dr. Leonard P. Schultz.

over, it was difficult to get the mice to eat fish flesh.

3. Extracts should be routinely prepared from muscle, liver, intestines and gonads. Muscle extracts from a given fish frequently produced negative results, but when the viscera from the same specimen were tested, the results were positive. In other specimens, the

reverse order of results was obtained; and various other combinations were found to occur.

4. Rats and hamsters are satisfactory test animals, but are more expensive than mice and do not appear more sensitive to the toxins.

5. Chickens and crayfish are apparently unaffected by the less virulent ichthyosarcotoxins. Dogs were not used because of their cost and our inadequate animal-house facilities.

6. Physiological saline was substituted for 0.1 N HCl as an extractant since there was no appreciable difference in results. Recent tests indicate that distilled water gives satisfactory results.

During the latter part of the investigation an attempt was made to check questionable or weakly positive specimens by feeding samples of the flesh to cats. In many instances it was necessary to utilize the entire specimen in preparing the extract and this precluded further analyses by feeding tests. Since our feeding results are rather meager, they will not be presented at this time. The studies conducted to date suggest that there is a high correlation between mouse injection and cat feeding tests.

Distribution of the Toxin Within the Fish

The location of the toxin within the body of the fish appears to be subject to considerable variation. It is commonly believed that fishes become poisonous as a result of their eating habits. The original substance may be a toxin or in the form of a non-toxic chemical constituent which is later metabolized into a toxic product. Poisonous fishes vary in their eating habits from herbivores to carnivores. If the toxins are derived from their food, then the active principal probably originates with a plant. According to this hypothesis, the cycle would be initiated by the herbivore or omnivore, which in turn may be eaten by a carnivore.

If the food chain theory is correct, then the distribution of the toxin within the body of the fish is probably governed by three principal factors, viz., venous drainage of the intestine, detoxication, and metabolic processes of the fish. When the active principal is ingested, it would be absorbed by the intestine, transported via the hepatic portal vein through the liver and then distributed throughout the body of the fish. The intestine and liver would receive the largest concentrations of the "toxic substances."[2]

The truth of this latter statement is suggested by the relatively shorter death-time intervals caused by liver extracts than those prepared from somatic muscle. Clinical case histories of tetraodon poisoning also indicate that the toxin potency of liver, per gram of tissue, is greater than that of muscle. One of the principal activities of the liver is that of detoxication. Blood passing from the liver would contain a lower concentration of the "poison" than the blood entering the liver. Concentrations of the "toxin" within a given organ would vary depending upon rate of metabolism, detoxication and the time interval after the ingestion of the active principal. Thus, one might expect to find a high concentration of the "toxin" within the liver and intestine and a low concentration within somatic muscle—if the fish had been captured soon after feeding on the source material. Samples taken at a later period would demonstrate the reverse situation since the toxicity level would have reached its peak within the somatic muscles and the material in the liver and intestine whould have been detoxified and eliminated. Physiological variation among species and individuals is another factor which should be considered. The correctness of this hypothesis can be determined only after conducting appropriate physiological, pharmacological and food chain studies.

Summary and Conclusions

The authors have presented the results of the poisonous fish investigations conducted in the Phoenix Islands during December, 1950, and January to April, 1951. Collections were made at Canton, Enderbury, Hull, Phoenix and Sydney Islands. McKean, Birnie and Gardner Islands were not visited nor were specimens obtained from them.

Toxicity tests were conducted on a series of more than 93 species of fishes (identifications on scarids and labrids are incomplete). Extracts were prepared from muscle, liver, intestines and gonads. Human physiological saline, 0.1 N HCl and distilled water were used as extractants. Tissue samples were homogenized in a Waring

[2] There is no evidence to indicate that the "toxic substance" is poisonous to the fish. The term "toxin or poison" is used in reference to its action upon mammals.

Blendor, centrifuged, and 0.1 ml. of the supernatant fluid injected intraperitoneally into mice for testing purposes.

Toxicity was neither species specific nor organ specific, but varied with the specimen in a random fashion. The viscera more frequently proved to be toxic than the musculature. Of the 93 identified species that were tested, 27 species or 29 percent were found to be toxic. There were 18 identified toxic specimens in which both the musculature and viscera were tested; 94 percent of these fishes had toxic viscera, but only 28 percent had toxic musculature. Twenty-two percent of the specimens had both toxic musculature and viscera. It should be remembered that the sample of the total population was relatively small.

Feeding tests were conducted on a limited number of specimens. Additional toxicity tests should be conducted on a larger series of reef fishes taken from representative areas in the Phoenix Islands. Although the aforementioned results cannot be considered conclusive, there is evidence to support the idea that a species may be poisonous in one area and edible in another.

Much of the data presented in this report are preliminary in nature and the reader is cautioned about forming premature conclusions.

In the opinion of the authors the public health significance of the poisonous fish problem has been grossly underestimated and is worthy of much greater attention than has been received to date.

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The Eels of the Genus *Stilbiscus*

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BETWEEN June 17 and July 15, 1952, the writer, while staying at the Lerner Marine Laboratory of the American Museum of Natural History,[1] at Bimini, Bahamas, B. W. I., was fortunate enough to collect seven eels of the Moringuoid genus *Stilbiscus*. On the basis of these specimens (ranging from 137.0 to 368.0 mm. standard length) it seems possible to clarify the nomenclature of the genus and also, on the basis of sea and aquarium observations of the living fish, to add something to our negligible knowledge of the habits and behavior of the group.

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TAXONOMY

The genus *Stilbiscus* was established by Jordan and Bollman (1889), who placed it in

the family Congridae. Gill and Smith (1900), without giving evidence, placed it in the family Moringuidae and synonymized the genus with *Moringua*. Mowbray (in Breder, 1927), apparently unaware of Jordan and Bollman's paper, redescribed and renamed the genus (as *Anguillichthys*), and established a new family for it (Anguillichthyidae). Parr (1930) recognized the synonymity of *Anguillichthys* with *Stilbiscus*, and erected still another family (Stilbiscidae), which he recognized as very closely related to the Moringuidae. Finally, Trewavas (1932), on osteological bases, placed the genus in the family Moringuidae.

The trivial names in the genus have gone through a less involved evolution. Jordan and Bollman described their single specimen (340 mm. total length) as *S. edwardsi*. Mowbray (*op. cit.*), without reference to previous papers, described his three specimens (115 mm. total length) as a new genus and species, *Anguillichthys bahamensis*. As Parr recognized, these specimens were significantly different from *S. edwardsi*, as were six of the eight stilbiscids (including the holotype) that he had himself studied; he therefore called these other, smaller fish *S. bahamensis* (Mowbray). Trewavas' two small specimens (123 and 135 mm. total length) were also referable to *S. bahamensis*.

Parr, however, pointed out that all of the known specimens of *S. bahamensis* were small (the largest was 140 mm. total length), and were males, and that the single larger (260 mm. total length) stilbiscid that he studied (he did not dissect the type) was a female; its proportions agreed well with those given for *S. edwardsi*. Since the differences between the two species were of size and proportion only, not of kind, he suggested the possibility that these differences were merely due to sexual dimorphism. This thesis is well borne out by the present series.

As will be seen by a comparison of the proportions of *S. bahamensis* and *S. edwardsi*, as given by Parr (1930), with those given below for, respectively, the male and female Bimini stilbiscids, there is little reason to doubt the identity of the two species with the two sexes, and hence, for the reasons mentioned above, the synonymity of the two species names. Even better agreement between these two sets of proportions will be obtained if the proportions in the present table (on the basis of standard lengths) are multiplied by the average proportionality factor of 0.990, to convert them to the total length base used by Parr.

The name of the species should be, therefore, *Stilbiscus edwardsi* Jordan and Bollman. The genus appears to be monotypic.

Using the linear approximation method of Parr (1949), the formulae for the changes in the relative proportions (expressed as thousandths of standard length $\times 10^3$) of head, lower jaw, snout, and interorbital distance of the females, approximate, respectively:

$$(0.1L + 48)^{\pm 5}_{250-370\text{mm.}}\ ;\ (-0.02L + 27)^{\pm 5}_{250-370\text{mm.}};$$

$$(0.01L + 10)^{+2}_{-3}{}_{250-370\text{mm.}}\ ;\ (0.01L + 6)^{+1}_{-2}{}_{250-370\text{mm.}}$$

The scatter of the measurements of the males, combined with the narrower range of lengths, makes it seem to the writer that it is not worth applying this approach to them. All available proportional measurements (not limited to those of the eels in the present series) for these four characters were used in calculating the above.

An examination of the proportions and of the plate given by Metzelaar (1919) for his *Moringua sp.* (= *M. boekei* Jordan, Evermann and Clark, 1930) makes it seem certain that this fish is not a *Stilbiscus*.

Behavior

Apparently all known specimens of this eel have been taken while swimming actively at night near surface lights. The members of the present series were all taken in a similar situation, by dip net, on ebbing tides, from the Laboratory dock on the lagoon side of the island of North Bimini. Mrs. Edith Bishop and Mr. Fritz Goro each captured one of these eels, and both very kindly gave their catches to the writer.

From the above it would seem that this species is an active, nocturnal, mid-water or surface-dwelling form. This, combined with Mowbray's observation of his three males swimming "with the posterior third of the body, keeping the anterior portion straight" (Mowbray, in Breder, 1927), would lend support to the theory, advanced by Mowbray and Trewavas, that there is an adaptive relation between the active habits of these eels and the

TABLE I

COUNTS AND PROPORTIONS OF SPECIMENS OF *Stilbiscus edwardsi* FROM BIMINI
Measurements in thousandths of standard length[1]

Character	July 14	June 20	June 17	July 14	June 20	June 17	July 15
Sex	Males			Females			
Standard length, mm.	137.0	139.0	149.0	281.0	285.0	338.0	368.0
Dorsal rays	25	36	27 ± 1	20+	26	32	28 ± 2
Anal rays	29 ± 1	27	26 ± 1	27	25	34	34
Branchiostegal grooves	5	5	5	5	5	5	5
Lateral line pores	91	100*	96	101	100	97	107*
Head length	0.109	0.094	0.117	0.073	0.081	0.086	0.079
Lower jaw length	0.022	0.022	0.020	0.018	0.019	0.018	0.016
Interorbital width	0.011	0.011	0.013	0.007	0.009	0.010	0.008
Snout length	0.018	0.014	0.020	0.012	0.011	0.015	0.011
Eye diameter	0.007	0.007	0.007	0.005	0.007	0.004	0.004
Pectoral length	0.029	0.018	0.030	0.012	0.018	0.015	0.015
Depth at pectorals	0.029	0.025	0.027	0.016	0.019	0.027	0.022
Width at pectorals	0.022	0.018	0.020	0.012	0.018	0.015	0.015
Snout to vent	0.683	0.680	0.728	0.691	0.707	0.695	0.682
Vent to tip of tail	0.319	0.320	0.272	0.310	0.293	0.305	0.318
Anal base, length	0.095	0.086	0.094	0.069	0.067	0.089	0.090
D. origin to C. base	0.252	0.230	0.235	0.226	0.221	0.219	0.234
Vent to anal origin	0.044	0.058	0.050	0.077	0.061	0.081	0.079
Anal to caudal base	0.274	0.263	0.221	0.233	0.232	0.223	0.239

[1] All original measurements accurate to approximately 0.5 mm.
* Continued series of small pores on caudal peduncle visible.

peculiar, "normal fish-like," development of their vertical fins.

The writer, however, in observing the eels of the present series both in the ocean and in aquaria with sand bottoms, has not been able to completely concur in this. Both in the sea and in aquaria they swam rapidly, but not especially so, in a seemingly ordinary eel-like fashion (successive sinusoidal waves passing down the length of the body), and in aquaria, burrowed rapidly into the sand bottom, seemingly no more rapidly than other eels of the area having the usual fin structure.

They seemed to do this last, however, only on exposure to bright lights. Observations made in aquaria, at night, by dim light, indicated that they swam about actively in the dark. This pattern is also duplicated in many respects in other eels found in the area (as by species of *Myrophis*).

An interesting feature of their burrowing activities was that they did this head first (due to their tail structure it seems unlikely that they could burrow in any other way, even if they "wanted" to). Eels, of similar size and of the genus *Myrophis*, taken under the same conditions as the stilbiscids, did their burrowing by backing in, tail first. The stilbiscids were also able to make rapid progress through the sand, a short distance beneath the surface, evidently by means of swimming motions.

On the basis of the above it seems to the writer that, qualitatively, these eels swim in the same manner as, are no more active than, and are no more exclusively a mid-water form than, other eels with "normal" vertical fins that occur in the same environment. Therefore, I cannot, at the moment, see any particular adaptive advantage accruing to this species as a result of its unusual vertical fin structure.

Unlike other eels, and many other fishes taken at the underwater light, the stilbiscids seemingly paid no, or very little, attention to the light. They were usually seen swimming rapidly at the surface, and deviated very little from their course when they entered the zone of brightness from the light. The possibility that this indicates the existence of a critical value of light intensity which "triggers" their

burrowing behavior (also possibly other types of behavior) should be investigated.

The possibility that these eels regularly come to the surface at night and wander over large areas also seems worthy of study.

Distribution

Eighteen of the twenty specimens of this species known to be in collections were taken between mid-March and mid-July at a variety of stations around the periphery of the Great Bahama Bank (3 ♂♂ and 4 ♀♀ at Bimini, 4 ♂♂ at Cat Island, 1 ♂ and 1 ♀ at Crooked Island, 3 presumed ♂♂ at Green Cay, 1 presumed ♀ (the holotype) at Green Turtle Cay, and 1 ♂ at Rum Cay). Of these eighteen specimens, ten are in the Bingham Oceanographic Collection, one (the holotype) is in the United States National Museum, and the present series of seven is in the American Museum of Natural History.

The other two specimens are both males, one collected definitely, the other possibly, in 1931 (but no dates given), and were taken at St. Lucia and Grenada, Windward Islands, B. W. I. They are at the British Museum (Natural History).

All specimens are apparently adults. Parr reported that, at the time of collection, the sperm was running from several of the males he studied. The vasa deferentia of the males of the present series seem to be enlarged, and the females have approximately the posterior three-quarters of their body cavities filled with spherical eggs, approximately 1/3 mm. in diameter, yellowish after preservation.

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Data on Dolphin, Yellowfin Tuna and Little Tuna from East Africa[1]

James E. Morrow

Between January 1 and March 31, 1950, the Yale East African Expedition collected a few specimens of dolphin, *Coryphaena hippurus* Linnaeus, yellowfin tuna, *Thunnus albacora* (Lowe), and little tuna, *Euthynnus affinis* (Cantor), along the East African coast between Mombasa and Zanzibar. These fishes were taken in relatively shallow water, roughly fifty fathoms or less. Most of them were caught on feather jigs trolled for catching bait, and because of the scarcity of this material, many of the specimens, as well as others not included in this report, had to be used for that purpose. However, length and weight were measured to the nearest centimeter and pound on 14 dolphin, 11 little tuna, and 29 yellowfin tuna. In addition, fin-ray counts were made on all the little tuna and on 28 of the yellowfin tuna. Samples of gonadal tissue were taken from all fish except one yellowfin tuna and two dolphin. The stomachs of nearly half the specimens of all three species were examined. Most of these were empty; the remainder contained

[1] Results of the Yale East African Expedition.

only a few fragments of partially digested fish flesh and bones. Although the data presented here are fragmentary, the lack of biological knowledge concerning these forms, together with the increasing interest in the biology of the tunas, suggest that this brief report may be worthwhile.

Dolphin

The 14 dolphin included here were caught near Shimoni, Kenya. This group included two males, ten females, and two specimens of undetermined sex which were probably females, as they did not show the vertical profile characteristic of adult males. The weight-length relationship, calculated by the method of least squares for a logarithmic transformation, yields the equation $W = 9.82 \times 10^{-8} L^{3.67}$, where W = weight in pounds and L = fork length in centimeters. This equilibrium constant of 3.67 is somewhat higher than that found by Schuck (1951) for dolphin from Atlantic waters off North Carolina. He obtained the figure 3.23 for his sample of 19 fish. However, the small size of the two samples and the large weight interval used render it unlikely that these figures are significantly different.

In addition to the 14 fish discussed above, the expedition also took 10 other dolphin, eight off Mombasa and two near Shimoni, which were measured but not weighed. These included six males between 57 and 74 cm. long, and four females between 65 and 70 cm. The lengths and weights of the 24 dolphin, segregated by sex, were as follows:

									Ave.
Males:									
Length, cm.	76	91	57	62	64	65	68	74	70
Weight, lb.	7½	14½	..	..	..	..	..	..	11
Females:									
Length, cm.	58	65	66	67	68	69	69		
Weight, lb.	3½	5	5½	5	5¼	5½	5½		
Length, cm.	72	73	82	65	68	70	72		69
Weight, lb.	6¾	6¼	9¼	..	..	..	..		5¾
Not sexed:									
Length, cm.	68	72							70
Weight, lb.	5	6							5½

The mean length of all 24 fish was 69.2 cm., 13.5 cm. less than the mean for Schuck's sample. The mean weight of 14 fish was 6.4 pounds, compared with 11.4 pounds in Schuck's fish. Our fish also tended to be lighter in weight among the smaller specimens, which accounts for the slightly higher equilibrium constant noted above.

Table I

Data on Little Tuna, *Euthynnus affinis*, from East Africa

Length, cm.	Weight, lbs.	Dorsal fin				Anal fin		
		Spines	Rays	Finlets	Rays + finlets	Rays	Finlets	Rays + finlets
Males (average below)								
52	4	15	12	8	20	12	7	19
54	5	15	12	8	20	13	7	20
56	6	15	11	8	19	13	7	20
63	8.5	15	11	8	19	13	7	20
70	11.5	14	12	8	20	14	6	20
71	11	15	12	8	20	13	7	20
61	7.7	14.8	11.7	8	19.6	13.0	6.8	19.8
Females (average below)								
53	5	15	12	8	20	14	7	21
58	6.5	14	11	8	19	13	7	20
60	6	14	12	8	20	13	7	20
68	9	15	12	8	20	14	7	21
66	...	15	12	8	20	14	7	21
61	6.6	14.6	11.8	8	19.8	13.6	7	20.6

Little Tuna

The 11 specimens examined, taken near Shimoni and along the west coast of Pemba Island, included six males and five females, ranging from 52 to 71 cm. in fork length and from 4 to 11.5 pounds in weight. One specimen, a female 66 cm. long, was not weighed. The weight-length equation, calculated as described above, is $W = 1.63 \times 10^{-6} L^{3.16}$. This closely approximates the "ideal" cubic relationship.

Table I shows the various measurements made on this species. It will be noticed that the variation in fin-ray and finlet counts is very small, with modal values for the dorsal fin and finlets of XV, 12, 8; for the anal fin and finlets, 13, 7. There appears to be a tendency for the males to have a slightly lower fin ray count, particularly in the anal fin and finlets. The differences between the mean counts for males and for females are not significant, except the count of anal rays plus finlets (Table I). The difference here is statistically significant at the 5 percent level. However, more

TABLE II

DATA ON YELLOWFIN TUNA, *Thunnus albacora*, FROM EAST ARICA

Length, cm.	Weight lbs.	Dorsal fin				Anal fin		
		Spines	Rays	Finlets	Rays + finlets	Rays	Finlets	Rays + finlets
Males (average below)								
54	4	14	13	9	22	14	8	22
55	5	14	14	9	23	13	9	22
55	5	14	14	9	23	14	8	22
56	4	14	14	9	23	14	9	23
57	7	14	15	8	23	14	8	22
59	5	14	14	9	23	13	8	21
62	9	14	14	9	23	14	8	22
64	8	14	14	9	23	13	9	22
70	11	14	14	9	23	14	7	21
70	12	14	14	9	23	13	9	22
72	16	14	14	9	23	13	9	22
72	16	13	14	9	23	14	8	22
75	19	13	14	9	23	13	9	22
76	19	14	15	8	23	14	8	22
78	16	14	14	9	23	13	8	21
80	28	14	14	9	23	13	9	22
87	27	..	14	9	23	13	9	22
54	6	..	..	..	..	..	..	..
66.4	12.1	13.9	14.0	8.9	22.9	13.5	8.4	21.9
Females (average below)								
48	4	13	14	9	23	14	8	22
54	5	13	14	9	23	13	9	22
55	5	14	13	9	22	13	8	21
68	10	14	14	9	23	13	9	22
68	11	14	14	9	23	13	9	22
68	11.5	14	13	9	22	12	10	22
70	15	13	14	9	23	13	9	22
77	20	14	14	10	24	14	8	22
79	22	..	14	9	23	14	8	22
65.5	11.5	13.7	13.8	9.1	22.9	13.3	8.6	21.9

and larger samples would be needed to determine whether this tendency actually exists in the whole population or has merely occurred here on a 1-in-20 chance.

YELLOWFIN TUNA

Twenty-nine specimens of this species, taken between Mombasa and the southern tip of Pemba Island, were examined. All were weighed and measured, but the sex of one specimen was not determined, and fin rays were not counted on another. These fish ranged from 48 to 87 cm. in fork length, and from 4 to 28 pounds in weight. The mean lenght was 68.3 cm., the mean weight 11.9 pounds. The sample included 18 males with mean length and weight of 66.4 cm. and 12.1 pounds, and 10 females with means at 65.5 cm. and 11.5 pounds. The weight-length equation is $W = 0.960 \times 10^{-6} L^{3.16}$. All these fish appeared to be sexually mature, although none was in spawning condition. Microscopic examination of gonadal tissue showed that several specimens had spawned recently, probably within six weeks or so preceding capture.

Table II lists the measurements and counts made on the yellowfin tunas. Comparison of these data with those in Table 10 of Godsil and Byers' (1944) work on Pacific tunas shows that we encountered a slightly greater range of variation in fin-ray and finlet counts than they found in yellowfin tuna from various parts of the Pacific Ocean. With respect to three characters, the modal values differ by one, but the direction of the difference is not consistent. Thus, the modal value in our sample for the number of dorsal finlets is nine, compared with eight reported by Godsil and Byers. Conversely, the modes for the number of dorsal and anal rays in our sample fall at 14 and 13, respectively, compared with 15 and 14. However, the first dorsal and anal finlets are sometimes attached to the corresponding fin, sometimes not, making it difficult to obtain a proper count. In all cases, if the finlet was attached to the fin, it was counted as a fin ray, not as a finlet. As Godsil and Byers pointed out, the sum of rays and finlets is a much more reliable character. In this respect, our specimens agree with those from the Pacific, having modal values of 23 dorsal rays plus finlets, and 22 anal rays plus finlets.

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Additional Records of Clinid Fishes, with the Description of a New Species of *Cryptotrema* from the Gulf of California

CLARK HUBBS

SINCE the publication of my revision of the Clinidae (Hubbs, 1952), eight specimens of the tribe Cryptotremidi which merit published record have come to my attention. Four of them belong to each of the two genera, *Alloclinus* and *Cryptotrema*. The four specimens of *Alloclinus holderi* from Baja California show that this species occurs on the outer coast of Baja California between Cape Tortolo and Los Coronados Islands. The four young *Cryptotrema* from off Angel de la Guarda Island in the Gulf of California differ sufficiently from *C. corallinum* to be considered a distinct species described below.

Alloclinus holderi (Lauderbach)

In my previous paper (Hubbs, 1952: 99), I listed the range of *Alloclinus holderi* as "from Cape Tortolo and Guadalupe Island, Baja California, to Santa Catalina Island, California. While this paper was in press Dr. C. L. Hubbs (personal communication) reports the capture of this species from Santa Cruz Island, California." Although the specimens reported in 1952 increased the known number of specimens from one to 43 (not including the Santa Cruz Island record), recent collections have added to the knowledge of the species. (Conrad Limbaugh of the University of California reports that it is common in the kelp holdfast zone off the coast of southern California). There has been no published record of *A. holderi* from between Cape Tortolo and Los Coronados Islands in Baja California, except for the offshore population from Guadalupe Island. The distance in miles and direction from Ensenada of each additional new locality is as follows: the San Benito Islands (250 SSE), Punta Rosarita (275 SE), Playa Marin Bay (240 SE), and Punta Banda (10 SW). I wish to thank Kenneth S. Norris of the Scripps Institution of Oceanography for collecting the last three specimens and sending them to me. The San Benito specimen is the only postlarval *Alloclinus* which I have seen. Except for the scarcity of chromatophores typical of clinid postlarvae, it differs very little from adult specimens. The anterior dorsal spines are not elongated. All three forms of the tribe have been collected in midwater.

***Cryptotrema seftoni*, sp. nov.**

On May 8, 1952, James E. Böhlke, Dan Cohen, Jon Lindebergh, and George Lindsay made a dredge haul from Joseph Sefton's yacht ORCA in 14 to 20 fathoms of water west of the north end of Angel de la Guarda Island in the Gulf of California. Due to a fortunate error the dredge did not reach the bottom and only one fish, a young *Cryptotrema*, was captured. In the following haul three additional young specimens of the same species were taken along with various other bottom fishes. All four specimens are between 32 and 35 mm. standard length. At this size *Cryptotrema* individuals appear to inhabit rock bottom frequently, but may be taken in midwater.

The name *seftoni* is proposed in honor of Joseph W. Sefton, Jr., of San Diego, who has done much to promote the investigation of the marine fauna and flora of the coasts of California and Baja California.

TYPES.—The holotype (Stanford University No. 17866), 34 mm. S.L., and two paratypes (United States National Museum No. 165475 and Texas Natural History Collection No. 3022) are from a dredge haul made by the yacht ORCA from 14 to 20 fathoms off the north end of Angel de la Guarda Island, Baja California, on May 8, 1952. The other paratype (SU No. 17877) is from a previous dredge haul at the same locality on the same day.

DESCRIPTION.—Dorsal XXVII, 11 to 12 (12 on holotype); anal II, 25 to 26 (26); total dorsal and anal rays 65 to 67 (67); caudal 11; pectorals 14; pelvics I, 3; branchiostegal rays 6; lateral line scales 63 to 65 (65); gillrakers 4 + 11.

The head and snout are pointed. Lips terminal, about twice as wide as suborbital. The upper jaw extends to below middle of eye. Interorbital flat. Opercle and preopercle smooth. Cirri, all short and simple, on nape, orbit, and anterior nostril.

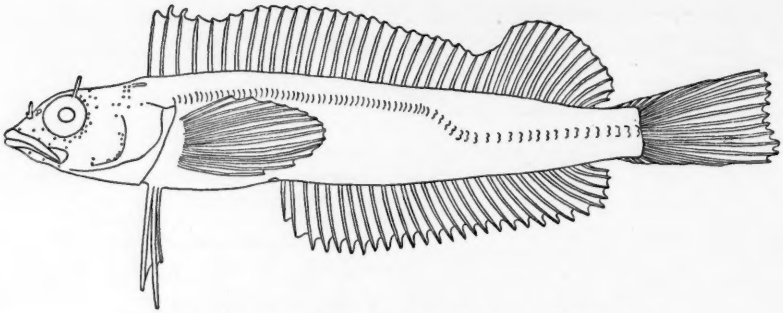

Fig. 1. *Cryptotrema corallinum*, 34 mm. S. L., from TNHC No. 421.

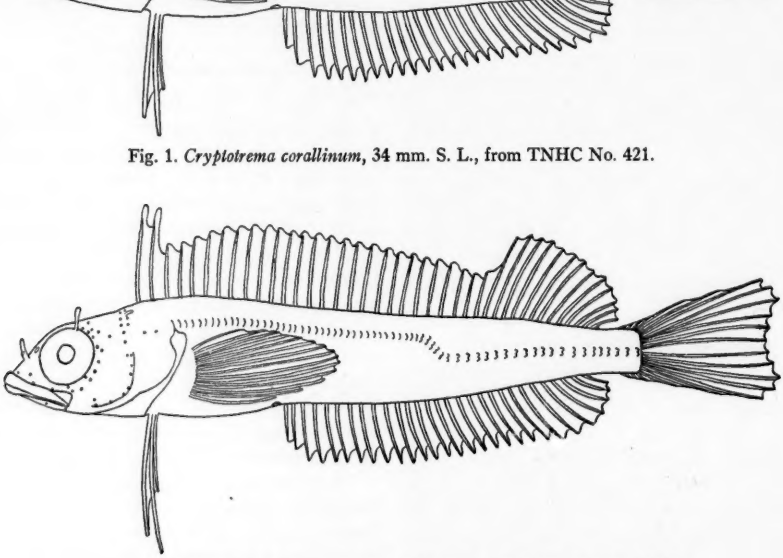

Fig. 2. Holotype of *Cryptotrema seftoni*, 34 mm. S. L., from SU No. 17866.

Conical teeth on premaxillaries, mandibles, vomer, and palatines. Those on the jaws consist of an outer row of enlarged teeth and an inner band of smaller teeth. Vomer and palatines have a single row of enlarged teeth.

The profile rises evenly to eye, then levels off and, except for a slight increase in depth at the nape, continues level to the dorsal soft rays, along which it drops to the horizontal caudal peduncle.

The first dorsal spine originates over the middle of the opercle. First spines thin and flexible, the others thin and inflexible. First spine long, more than twice length of opercle. Second spine slightly shorter. Third very much shorter, contained 1.5 to 2.0 times in first. Fourth spine equal to third or slightly longer. The spine length gradually increases to the tenth, which is contained 1.1 to 1.4 times in the first. The spine length then decreases to the next-to-last, which is approximately equal to the third and fourth. The length of the anterior soft rays slightly exceeds the first spine length. Less than the proximal half of the last ray is attached to the caudal peduncle by a membrane.

The principal caudal rays are not divided. The fin is very slightly forked.

The first anal spine is contained in the second spine and first soft ray 1.5 and 2.3 times, respectively. The following soft rays are approximately equal except for the last three, which are shorter.

The longest pectoral ray reaches a point above the base of the second to fourth anal soft ray. The second pelvic soft ray almost reaches the anal; the first is slightly shorter; and the splint-like third is half as long as the second.

The body and head are naked anterior to a line extending from the anus anteriorly toward the lower end of the pectoral base, behind

which the line runs to the naked opercle. Above the lateral line the body is naked anterior to the fourth spine.

The lateral line extends posteriorly in a straight line to a point below the twentieth to the twenty-second dorsal spine, then on about four scales drops to the midline, on which it extends to the end of the caudal peduncle.

The color pattern as exhibited by the four preserved specimens is very consistent and almost identical with that of the freshly-caught young of *C. corallinum* (TNHC No. 421), on which I based a large part of my description of the color pattern of *corallinum* (Hubbs, 1952: 101).

COMPARISONS.—The Gulf *Cryptotrema* differs from *C. corallinum* in three details: the eye is larger (causing measurements based on the margin of the orbit to be smaller); the first two dorsal spines are elongated and very much longer than the third (the three spines are all nearly equal in *C. corallinum*); and the lateral line scales number 63 to 65 (*C. corallinum* has 65 to 72). It is possible to use these characters to separate not only adults of *C. corallinum* but also a 34 mm. young from Los Coronados Islands (TNHC No. 421) from the Gulf of California specimens. (The short first dorsal spines of the postlarva of *A. holderi* also indicate that this character does not change with age.) Other differences between the four Gulf specimens and the California adults are based on age.

Thus the young fish have: a larger eye (the eye of young from the Gulf is even larger, Figs. 1 and 2); fewer branches on the cirri; no branched caudal rays; a somewhat forked caudal; and scales not yet developed in a rather large area immediately behind the head and between the lateral line and dorsal fin.

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Postlarvae and Young of the Menhaden (*Brevoortia tyrannus*) in Brackish and Fresh Waters of Virginia[1]

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ALTHOUGH menhaden are among the most abundant fishes of the Atlantic Coast, little seems to be known of the distribution of larvae and juveniles. Radcliffe collected larval menhaden in Woods Hole Harbor, Massachusetts, and one was taken in St. George Sound, Florida (Kuntz and Radcliffe, 1917). Perlmutter (1939) obtained 141 larvae from the waters of Long Island Sound and Merriman and Warfel (1944) reported them in New Haven Harbor, Connecticut. In Chesapeake Bay, Kuntz and Radcliffe (1917) collected menhaden larvae from the mouth of the Potomac River in February, while Hildebrand and Schroeder (1928) reported 19 larvae in the Bay in January and March. Pearson (1941) obtained menhaden larvae in samples taken near Old Point Comfort during April and May. None of these records indicates the occurrence of postlarval menhaden in brackish or fresh waters.

Young menhaden, although generally common in salt water, have not often been taken in fresh water. Ellison (1951) stated that the young seemingly enjoy an environment that varies from slightly brackish to the normal salinity of sea water. Raney (1950) concluded that menhaden wander into fresh water in the James River, but do not remain there long. Gunter (1945) indicated that *Brevoortia* sp. is a brackish-water species as compared with *B. tyrannus*.[2]

[1] Contributions from the Virginia Fisheries Laboratory, No. 45.

[2] As Hildebrand (1948) has pointed out, these species are *B. gunteri* and *B. patronus*, respectively; they do not occur along the Atlantic Coast.

Menhaden spawn in Chesapeake Bay during the winter (Hildebrand and Schroeder, 1928). The distance upriver that spawning may occur is not known. However, neither menhaden eggs nor adult menhaden have been found in the brackish or fresh waters of any Virginia rivers during February or March.

Methods of Capture

Plankton sampling.—Menhaden larvae and young have been collected in brackish and fresh waters of the James, Chickahominy, Pamunkey, Mattaponi, and Rappahannock rivers during April and May, 1950 to 1952. Since the sampling was done primarily to obtain information on the extent of the spawning areas of shad and striped bass (Massmann, 1952 and Tresselt, 1952), only the brackish and fresh waters were surveyed. Sampling in the Rappahannock River was most intensive, and the data from collections made there in 1951 are presented in detail. A 57-mile section of river was sampled between Tappahannock, which is 37 miles from Chesapeake Bay, and the fall line near Fredericksburg, 93 miles above the river mouth. Weekly from March 26 to May 21 the river was sampled by plankton nets of nylon marquisette (about 25 meshes per inch), one meter in diameter at the mouth. Two nets were set at each station, one at the surface and one at the bottom, for intervals of one to two hours. The James, Chickahominy, Pamunkey, and Mattaponi rivers were sampled in less intensive fashion from the vicinity of brackish water to near the head of the tide.

Minnow-seine sampling.—Minnow-seine sampling was done in the Rappahannock River during the period June 15 to July 15, 1951. Forty-two samples were taken between Tappahannock, eight miles downriver from the approximate boundary of fresh and brackish water, and a station 33 miles upriver from this boundary. The seine, 20 feet by 5 feet with ¼-inch mesh, was usually hauled a linear distance of 400 feet parallel to shore. Most stations were sampled at least three times during the month of seine collecting. Only in the Pamunkey River, where 85 samples were taken during the summers of 1949, 1950, and 1951, was minnow-seine sampling done at stations located from brackish waters almost to the head of tidal waters.

Surface trawl sampling.—The Rappahannock River was sampled with a surface trawl during the period September 25 to October 1, 1951. The net, a 30-foot shrimp trawl of one-inch webbing with a ¼-inch mesh liner in the cod end, was towed at the surface by two boats (Massmann, Ladd, and McCutcheon, 1952). Eight 15-minute hauls were made at night at stations located between the approximate boundary of brackish and fresh water and the head of tide.

Salinities were measured with a standard salinometer, corrected for temperature. The accuracy of these instruments is questionable

Table I

Menhaden Postlarvae in the Rappahannock River

The number collected per net hour from surface plankton samples in 1951. Mean values are determined by using only those samples taken from April 9 to May 14, which probably represents the range of the larvae within the sampling area at this period. Samples were taken with nets one meter in diameter at the mouth, set in a current from one to two hours

Distance upstream[1]	Cruise week									
	March 26	April 2	April 9	April 16	April 23	April 30	May 7	May 14	May 22	Mean
−2.5	...	...	...	...	1338.0	1098.0	260.6	18.9	0.0	678.87
2.5	...	...	...	...	22.0	0.0	1.7	0.0	0.0	5.93
7.5	0.0	0.0	0.0	1.0	1.3	0.0	0.0	0.0	0.0	0.38
12.5	...	0.0	0.0	...	1.7	0.0	...	0.0	0.0	0.44
17.5	...	0.0	0.2	0.0	...	0.0	0.0	0.0	0.0	0.04
22.5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.03
27.5	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.06
Mean.....	...	...	0.03	0.20	173.21	122.00	32.99	2.10	0.0	...

[1] Nautical miles upstream from approximate boundary of brackish and fresh water expressed by the mid-points of five-mile river intervals.

for readings more precise than 1 part per thousand.

Results

Distribution of postlarvae.—In the plankton nets more than 8,000 menhaden postlarvae were collected, ranging in standard length from 24 to 30 mm. As compared with bottom samples, the ratio of larvae at the surface was 200 to 1; thus it is evident that fish of these sizes swim near the surface. Since the bottom nets sampled the upper levels briefly during setting and retrieving, the few larvae obtained in them could have been caught at any level. Table I shows the distribution and relative abundance of menhaden larvae at 7 of 12 stations sampled during the nine-week period; the other five stations, farthest upstream, yielded no postlarvae. Although larvae were collected 27 miles upriver from brackish water, 98 percent were taken at station 37 where the mean salinity reading was 2 parts per thousand at the surface and 3 parts per thousand at the bottom. No samples were obtained at stations 37, 41, and 45 until April 23. Plankton samples from brackish and fresh waters in the James, Chickahominy, Pamunkey, and Mattaponi rivers during April and May, 1949 to 1952, establish the presence of larval menhaden in the fresh waters of these rivers (Table II).

Distribution of young.—Minnow-seine sampling in the Rappahannock River has demonstrated that young menhaden (mean standard length 40.6 mm.), the most abundant species in the shore zone (Table III), were concentrated just above brackish waters. They were collected only during the first part of the sampling period, none being taken in July even at stations that had previously been most productive.

In the Pamunkey River, 116 young menhaden were captured. Most were taken in the 10-mile section of river immediately above the boundary between brackish and fresh water, and only a few were taken at stations located 20 miles beyond brackish waters. All the young menhaden were collected in June and early July. None was taken in late July, August, or September.

The distribution of young menhaden in surface trawl hauls (Table IV) appeared to be

Table II

Menhaden Postlarvae Collected in the James, Chickahominy, Pamunkey and Mattaponi Rivers

The number collected per net hour from surface plankton samples in 1950, 1951, and 1952. Samples were taken with nets one meter in diameter at the mouth, set in a current for approximately one hour

Distance upstream[1]	James[2]	Chickahominy[3]	Pamunkey[4]	Mattaponi[5]
−2.5	...	...	...	0.94
2.5	...	...	1.60	0.86
7.5	...	...	1.14	92.64
12.5	3.78	...	0.0	0.0
17.5	0.16	12.57	1.62	0.0
22.5	0.0	...	0.08	0.0

[1] Nautical miles upstream from approximate boundary of brackish and fresh water expressed by mid-points of five-mile river intervals.
[2] Sampled April 14–May 8, 1952. Sampling time average 12 hours in each five-mile river section. No larvae were collected at stations 27.5, 32.5, 37.5, 42.5, and 47.5 miles upstream.
[3] Sampled April 14–May 7, 1952. Sampling time 14 hours.
[4] Sampled April 4–12, 1950 and May 28–29, 1951. Sampling time averaged 4.5 hours in each five-mile river section. No larvae were taken at stations 27.5, 32.5 and 37.5 miles upstream.
[5] Sampled April 13–19, 1950 and May 30, 1951. Sampling time averaged 7.5 hours in each five-mile river section.

Table III

Young Menhaden in the Shore Zone of the Rappahannock River

The number collected in minnow-seine samples June 14 to July 15, 1951. A 20-foot by 5-foot seine of 0.25-inch mesh was used

	Mid-points of five-mile river intervals							
Distance upstream	−7.5	−2.5	2.5	7.5	12.5	17.5	22.5	27.5
Number of menhaden per 100-foot seine haul..	1.3	29.8	164.7	29.5	6.3	3.0	0.0	0.0

Table IV

Young Menhaden in the Offshore Zone of the Rappahannock River

The number collected in night surface trawl samples, September 25 to October 1, 1951. A 30-foot trawl of one-inch webbing with a 0.25-inch mesh liner in the cod end was used

	Mid-points of five-mile river intervals									
Distance upstream ..	2.5	7.5	12.5	17.5	22.5	27.5	37.5	42.5	47.5	52.5
Number of menhaden per 15-minute trawl tow.....	2685	281	355	268	...	47	144	..	0	0

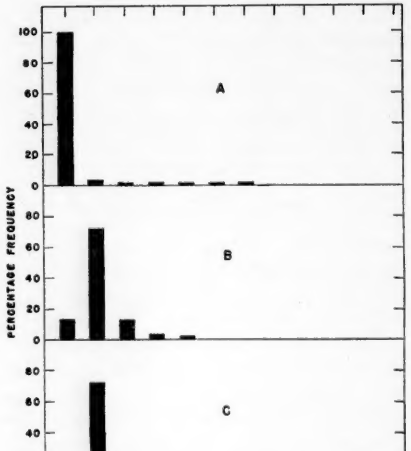
PERCENTAGE FREQUENCY
A
B
C
-2.5 2.5 7.5 12.5 17.5 22.5 27.5 32.5 37.5 42.5 47.5 52.5
NAUTICAL MILES UPSTREAM FROM APPROXIMATE BOUNDARY OF BRACKISH AND FRESH WATER

Fig. 1. The percentage distribution of postlarval and young menhaden in the brackish and fresh waters of the Rappahannock River, Virginia.
A: taken by plankton net, March 26 to May 22, 1951; B: taken by minnow seine, June 15 to July 15, 1951; C: taken by surface trawl, September 25 to October 1, 1951.

similar to the distribution pattern deduced from minnow-seine samples. Menhaden averaging 94 mm. in standard length were most abundant immediately upstream from brackish water (no sampling was done in brackish water). Although menhaden were found 15 miles further upriver by surface trawl than by seine, the trawl obtained larger samples than did the seine; therefore, the wider distribution may have reflected more effective sampling.

Summary and Conclusions

Postlarval menhaden collected in brackish and fresh waters appear to have originated from spawnings in Chesapeake Bay or from waters of higher salinity near the river mouths. In moving upriver, the postlarvae were most abundant near the surface. Such a movement upriver in the surface water of the saline portions of the river would be undertaken against a nontidal surface current flowing toward the Bay (Pritchard, 1951). Since the nontidal current near the bottom in saline portions of the river is directed upstream, it would appear that larval menhaden moving upriver would progress more rapidly by swimming near the bottom rather than at the surface.

The disappearance of larval menhaden from plankton samples appears to have been caused by an increase in their ability to avoid the nets or an inshore movement rather than migration out of the river, for larger individuals were taken by other methods as late as October. Minnow-seine hauls showed that young menhaden, present in the shore zone in late June, were uncommon in this region later in the season. Surface trawl hauls made in late September and October indicated that young menhaden had moved out over deeper waters beyond the reach of minnow seines.

The relative abundance of postlarvae was greatest in samples obtained downriver from the approximate boundary of brackish and fresh water, while young menhaden from minnow-seine hauls were most abundant just above that boundary (Fig. 1). Surface trawl hauls indicate a similar distribution, although no hauls were made with this gear in brackish waters.

All the sampling was done near the edge of the range of these fishes in fresh water, and none in the lower parts of the estuaries, or within Chesapeake Bay itself. Presumably, the relative abundance of all sizes of menhaden is greatest in salt water. Sampling the margins of the range of distribution of the species, however, offers some interesting possibilities. For example, marked annual variations in the abundance of the early stages upriver might be correlated with total abundance, and thus afford an index of the success of spawning from year to year. In this connection, postlarval and young menhaden seemed less abundant in the Rappahannock River in 1952 than in 1951. Furthermore, the numbers of schools of young menhaden observed casually in other areas of Chesapeake Bay appeared to be much less in the summer of 1952 than in 1951. It is tempting to suggest that the menhaden year-class which was spawned in the winter of 1950–51 may have been much more successful than that produced in the following winter.

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VIRGINIA FISHERIES LABORATORY, GLOUCESTER POINT, VIRGINIA.

The Influence of Light on the Number of Vertebrae in the Grunion, *Leuresthes tenuis*[1]

J. L. McHUGH

IT is well known that the mean numbers of vertebrae in fishes can be influenced by environmental factors, notably temperature and salinity, during the early developmental stages (Schmidt, 1918, 1919, 1920, 1921; Tåning, 1944, 1952; Heuts, 1946). Undoubtedly other environmental factors produce similar effects (Vladykov, 1934; Johnsen, 1936), although investigations along these lines have not been extensive. Dannevig (1932) has suggested that the number of vertebrae in the cod may be influenced by light intensity, and it has been stated (Worth, 1898) that the hatching of shad eggs is speeded in direct sunshine, and that continuous dark and cloudy days will retard, and strong light will accelerate, development under equal conditions of temperature. Willer (1928) also has found that light affects the rate of development of fishes. More recently, Hoover and Hubbard (1937) have found that the sexual cycle in trout can be modified by control of light, and this knowledge has been put to practical use by the Fish and Game Department of New Hampshire (Bernard W. Corson, personal communication).

The experimental results reported here can not be considered conclusive. Nevertheless, they bear on the results of investigations shortly to be reported, and add to the scanty literature relating to the effect of light on animal development. The experiments were designed originally to determine the effects of temperature and salinity on mean vertebral number in the grunion, *Leuresthes tenuis* (Ayres). It soon became apparent that the results were too variable to be of value for this purpose. In searching for the cause of this variability, it was realized that the amount of light falling on the experimental lots was not under control, and a further experiment was conducted to investigate the effects of this factor.

Eggs from a single female were fertilized in the laboratory by sperm from a single male. The fertilized eggs were separated into three lots and were placed in beakers of sea water. The three beakers were immersed in water in a

[1] Contributions from the Scripps Institution of Oceanography, New Series, No. 636.

TABLE I

INFLUENCE OF LIGHT ON THE MEAN NUMBER OF VERTEBRAE IN THE GRUNION (*Leuresthes tenuis*)

Type of illumination	Number of vertebral centra			Mean	Number[1]	$S(x-\bar{x})^2$
	47	48	49			
Bright	14	11	..	47.44	25	6.16
Subdued	18	22	..	47.55	40	9.89
Darkness	52	157	2	47.76	211	42.16

[1] The original samples contained approximately identical numbers of eggs, and a good hatch was obtained with each lot. The discrepancy in numbers in the final samples is the result of mortality after hatching, during the month in which the fish were held in tanks. It is possible that the factors associated with the death of these fish were selective with respect to vertebral number.

TABLE II

THE NUMBERS OF VERTEBRAE IN SAMPLES OF *Leuresthes tenuis* REARED IN TEMPERATURE AND SALINITY EXPERIMENTS, GROUPED ACCORDING TO THE INTENSITY OF LIGHT DURING EMBRYONIC DEVELOPMENT

Type of illumination	Number of vertebral centra					Mean	Number	$S(x-\bar{x})^2$
	46	47	48	49	50			
Bright	11	119	65	1	..	47.29	196	64.00
Subdued	8	160	184	12	1	47.56	365	136.10
Darkness[1]	..	19	32	1	..	47.65	52	13.77

[1] Adult fish from nature. The developing eggs are buried in the sand, hence no light can reach them.

large glass aquarium in a controlled-temperature room. One beaker was painted black and was provided with an opaque cover; the second was shaded from the direct light entering the windows in daytime, and was illuminated from above by a 100-watt bulb at a distance of about five feet; the third was exposed to direct light from the windows during the day, and received the same illumination as the second beaker at night. The second and third beakers were provided with covers of transparent glass. Until hatching occurred, about ten days after fertilization, the room was maintained at an average temperature of about 24° C. No significant differences in water temperature were observed in the three beakers. Aeration was provided by a thin stream of air bubbled into each.

At hatching, the prolarvae were transferred to three aquaria of aerated standing sea water under equal conditions of temperature and light. The young fish were fed with brine-shrimp nauplii (McHugh and Walker, 1948) until they were about one month old. This was necessary to ensure ossification of the vertebral columns. At this stage the young were killed in a five percent solution of formalin buffered with borax, and after a period of hardening, the tissues were cleared and the bones stained by the KOH-Alizarin-Glycerine method.

The vertebral counts are given in Table I. Analysis of variance of the means shows that there is little chance that the three lots could have been drawn from the same population ($F = 7.85$, $F_{0.01} = 4.7$). The experiment seems to show, at a high level of statistical significance, that the mean number of vertebrae in the grunion can be modified by light during the embryonic stages.

A large-scale experiment, planned to confirm the validity of these results, unfortunately failed due to technical difficulties, and it was not possible to repeat the experiment later. Indirect confirmation, admittedly inadequate, is afforded by the results of the previous studies. Although water temperatures and salinities were varied in these experiments, the mean numbers of vertebrae showed no regular variation with either factor. Ignoring the possible complicating effects of these other factors, and grouping the experimental lots in broad categories according to the intensity of the incident light, the figures in Table II were obtained. Analysis of variance of these means indicates, also at a high level of statistical significance ($F = 15.56$, $F_{0.01} = 4.65$), that the three composite samples could not have been drawn from the same population. Furthermore, the conclusion again is reached that an inverse relationship exists between light intensity and the number of vertebrae produced.

It is not well understood by what mechanism light is able to affect metabolism during early development. Heilbrunn (1943) stated that the visible light increases the cellular permeability of plants, but that little work has been done along these lines on animals. He did point out, however, that the permeability of blood cells is greater in light than in darkness. Perhaps by some such action, light is able to alter the rate of metabolic activity, as temperature is known to do. The production of low numbers of vertebrae at high temperatures seems somehow to be related to the more rapid rates of

development and differentiation occurring under such conditions, and variations in the balance between these two processes.

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Observations on the Comparative Ecology of Two Species of Fish, *Cottus asper* and *Cottus rhotheus*, in British Columbia[1]

THOMAS G. NORTHCOTE

TWO closely related species of freshwater cottids, *Cottus asper* Richardson and *Cottus rhotheus* (Rosa Smith), cohabit the Arrow Lakes in British Columbia. The similar morphology and ecology of these species suggest a competitive situation and this fact has prompted consideration of some phases of their interrelationship. The study is based on specimens collected from Lower and Upper Arrow Lakes in the summer of 1949 in conjunction with a limnological survey made by the British Columbia Game Department and the University of British Columbia.

The author is grateful to Dr. P. A. Larkin for his interest, guidance and criticism throughout. Likewise, the advice, suggestions and criticisms of Dr. W. A. Clemens and Dr. C. C. Lindsey are sincerely appreciated. Collection of material was made possible through the joint sponsorship of the British Columbia Game Department and the University of British Columbia. The assistance of Mr. Craig MacPhee and Mr. Charles Lyons in collecting material is gratefully acknowledged.

HABITAT.—The Arrow Lakes lie in a narrow, deep trench continuous with the Columbia River in the West Kootenay district of British Columbia. Upper Arrow Lake, about 40 miles long, is connected to Lower Arrow Lake, of similar length, by 15 miles of river. For the most part, the shoreline of both lakes is steep and rocky with a few sand or gravel beaches.

Several beach seine hauls were taken at each of nine localities on the Arrow Lakes. *C. asper* and *C. rhotheus* appeared together at six localities, suggesting a close association between the two species in the upper littoral zone of these lakes.

[1] Contribution from the Department of Zoology, University of British Columbia, Vancouver, B. C., and the British Columbia Game Department.

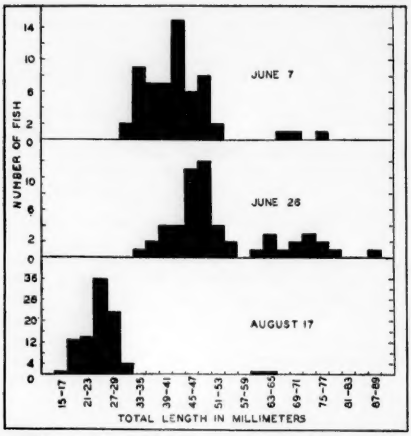

Fig. 1. Length-frequency distributions of 206 specimens of *Cottus asper* from the Arrow Lakes.

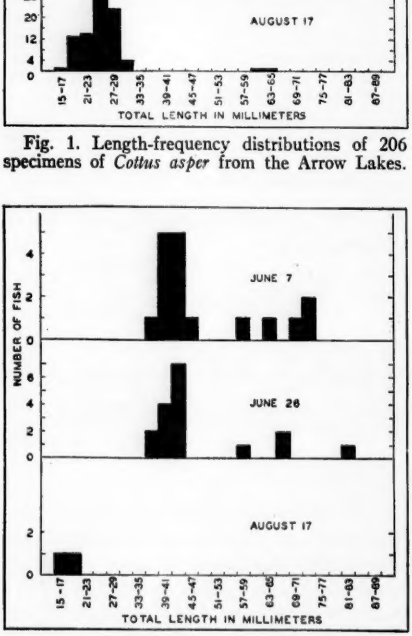

Fig. 2. Length-frequency distributions of 36 specimens of *Cottus rhotheus* from the Arrow Lakes

AGE DETERMINATION.—Age determination was restricted to the length-frequency method, as the absence of scales in freshwater sculpins prevented use of the common method, and as the otoliths were decalcified by preservation in formalin.

Measurement of total length in 206 *C. asper* and 36 *C. rhotheus* indicated division of each species into at least two modal groups (Figs. 1 and 2). The first modal group occurs between 15 and 30 mm. and probably represents young of the year, as no specimens within this group were collected before the middle of August. The second modal group, lying between 35 and 55 mm. in each species, probably represents yearling fish. Beyond lengths of 55 mm. the significance of size distribution in relation to age is obscure.

SEXUAL MATURITY.—Gonads of the fry of *C. asper* and *C. rhotheus* showed no obvious differentiation. Ovaries of yearlings were clearly differentiated, but little change in development was noted between June and August. Gonads in larger size groups taken in June were mature and in spawning condition, although no fish was found which obviously had spawned earlier that year. These observations on age and state of maturity, along with the presence of fry of both species in August, indicate that *C. asper* and *C. rhotheus* do not spawn until at least the late spring of their second year.

FOOD.—A study of food habits of the two species was made by stomach content analysis; the relationship between some morphological differences and food habits of each species was considered.

The stomachs of 211 *C. asper* and 38 *C. rhotheus* were examined; 18 of the former and two of the latter were empty. It is evident (Table I) that both species feed upon similar groups of organisms. All groups, except Cladocera, represented in stomachs of *C. asper*, were also found in stomachs of *C. rhotheus*. The diet of these two sculpins included a wide variety of organisms, from small invertebrates to larger vertebrates of their own class.

Volumetric stomach content analysis for individual small sculpins was not practical; determination was made of the volume of food items from all fish in particular size groups. The volume of food items was measured to the nearest 0.01 ml. by (1) drying the food on blotting paper for five minutes, (2) placing it in a vial calibrated to 1.00 ml., and then (3) filling the vial to 1.00 ml. with water from a pipette calibrated to 0.01 ml., and measuring the displacement by titer from the pipette.

Percentage volume and occurrence of food items for size groups of the two species are shown in Figure 3. "Crustacean plankton" includes all Entomostraca. *Cyclops* sp. was the most abundant plankter in the stomachs and was found in most size groups of both species. Cladocera were rare in *C. asper* and not recorded in *C. rhotheus*.

TABLE I

FOOD OF *Cottus asper* AND *Cottus rhotheus* FROM THE ARROW LAKES, BRITISH COLUMBIA

Numbers in parentheses indicate number of specimens examined

Cottus asper (193)	*Cottus rhotheus* (36)
Pelecypoda	Pelecypoda
Sphaeriidae	Sphaeriidae
Crustacea	Crustacea
Cladocera	
Copepoda	Copepoda
Cyclops sp.	*Cyclops sp.*
Diaptomus sp.	
Ostracoda	Ostracoda
Amphipoda	Amphipoda
Hyalella azteca	*Hyalella azteca*
Insecta	Insecta
Plecoptera	Plecoptera
Ephemeroptera	Ephemeroptera
Hemiptera	Hemiptera
Notonectidae	
Trichoptera	Trichoptera
Diptera	Diptera
Chironomidae	Chironomidae
Ceratopogonidae	Ceratopogonidae
Unidentified larvae	Unidentified larvae
Pisces	Pisces
Cyprinidae	Cyprinidae
Richardsonius balteatus	*Richardsonius balteatus*
	Ptychocheilus oregonense
Unidentified genera	Unidentified genera

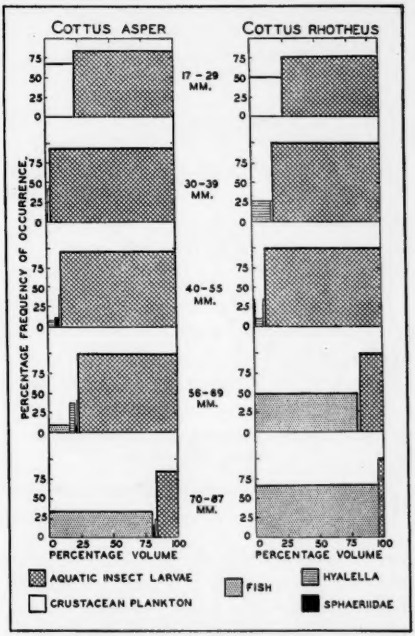

Fig. 3. Food of 193 specimens of *Cottus asper* and 36 specimens of *Cottus rhotheus* from the Arrow Lakes, British Columbia.

Fry of both species fed exclusively on plankton and aquatic insect larvae, the latter largely chironomids and a few mayfly nymphs. In the second size group of both species (30–39 mm.) aquatic insect larvae formed the bulk of the diet. Crustacean plankton was recorded in less than half the stomachs and volumetrically contributed less than for the fry. In the third size group aquatic insects, chiefly mayfly nymphs, were the major food item for both species of sculpin. Plankton did not contribute significantly to the diet of either species. In the fourth size group, 56 to 69 mm., aquatic insect larvae formed the greater part of food for *C. asper.*, although in this size group a new item, fish, had made its appearance. In *C. rhotheus*, however, fishes were the most important item, and aquatic insect larvae secondary. In the last size group, 70 to 87 mm., fishes predominated in the stomachs of both species, and aquatic insect larvae formed a minor food source.

Mouth sizes of *C. asper* and *C. rhotheus* were measured to determine if a significant difference exists between the two species and to consider the relationships between mouth size and food items taken. The maximum distance between the lateral surfaces of the mouth was used as a measurement of mouth width. All measurements were taken with calipers equipped with vernier for estimation to the nearest 0.1 mm. and are recorded (Fig. 4) for 34 specimens of *C. asper* and 31 of *C. rhotheus*. It is evident that between lengths of 35 and 80 mm., *C. rhotheus* has a relatively broader mouth than *C. asper*. No sexual dimorphism was noted in this measurement.

Many of the food items found in stomachs of *C. asper* have been reported previously. Munro and Clemens (1937) found midge larvae, caddis larvae, mayfly and stonefly nymphs, aquatic Hemiptera, *Hyalella*, and the redside shiner (*Richardsonius balteatus*) in stomachs of this sculpin. Clemens, Rawson and McHugh (1939) found that food of small *C. asper* from Okanagan Lake consisted of copepods, cladocerans and chironomid larvae, while larger individuals ate chironomids and other aquatic insects. Fish

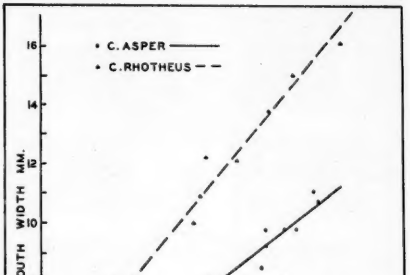

Fig. 4. Variation in mouth width in two species of *Cottus*.

remains were found in only one of ten stomachs of larger specimens (28 to 77 mm.). Ferguson[2] reported chironomid larvae, cladocerans, gastropods, and copepods in 14 stomachs of *C. asper*, 25 to 92 mm. long, from Skaha Lake.

In the present series of specimens, *C. asper* and *C. rhotheus* exhibit a marked change in diet with increasing length which may be related to increase in mouth size. Moreover, the difference in mouth size between the two species appears to be reflected in their diets, for wherever there was a change in the type of food eaten by either species, this change was first evident or more significant in the diet of *C. rhotheus*. For example, *Hyalella* first appeared in the second size group (30 to 39 mm.) of *rhotheus* but in the third size group (40 to 55 mm.) of *asper*. Likewise, fishes occurred in the diet of both species in the fourth size group (56 to 69 mm.) but were found in greater abundance in *rhotheus*.

The size of an animal's mouth obviously puts some limit on the size and type of food which it may consume. Elton (1927) noted this and discussed its ecological significance. From the present study it appears that the relationship between food size and mouth size may be quite exacting, for when the same length groups of the two cottids are compared, differences in diet are evident, even with minor differences in mouth size. Furthermore such minor morphological differences may have a considerable competitive significance, as larger food organisms become available to *C. rhotheus* sooner than to *C. asper*.

[2] R. G. Ferguson. 1949. Fish interrelations and the production of Kamloops trout. B. A. thesis, Dept. of Zoology, University of British Columbia.

ECOLOGICAL RELATIONSHIPS.—The two closely related species inhabit the upper littoral zone of the Arrow Lakes and utilize principally the same food resources of that environment. By definition of competition as "demand at the same time by more than one organism for the same resources of the environment in excess of immediate supply" (Crombie, 1947), it would appear that such a condition could exist here. The qualifying factor is whether the demand of the two species upon the food resources is in excess of supply. No study was made of the availability of food eaten by *C. asper* and *C. rhotheus*, and even in the event of such a study it would be difficult to determine whether demand was greater than the supply. It is evident therefore that the competitive relationships between these two species cannot be determined on the basis of available data.

If competition for food and other resources of the environment were severe between the two species, or in other words if they occupied the same ecological niche, one species would be expected to replace the other according to the thesis of Gause (Gause and Witt, 1934). However, diversity of habitat in the littoral zone of the Arrow Lakes, even in the presence of competition in some areas, may permit indefinite occupation of the lakes by *C. asper* and *C. rhotheus*.

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Definitions and Derivations of Various Common Measures of Mortality Rates Relevant to Population Dynamics of Fishes[1]

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ALTHOUGH various measures of mortality rates have been used to estimate population sizes, and the effects of fishing on stocks of fishes, the applications in the literature seldom contain derivations and definitions of the parameters estimated. When these are included, there is a marked lack of consistency in the notation used for identical parameters. See, for example, Baranov (1918), Ricker (1940) and Beverton and Holt (In press).

Some of the parameters are definitions and some are derived from the defined parameters. (Usually the difference between a definition and a derivation is that the derivation involves certain assumptions made during its development from definitions.) The arguments leading to these derivations are lacking or widely scattered in the literature.

It is my intention, then, to gather in one place the definitions and derivations, to present the logical basis for the derivations, and to record some of the notations used for these and other parameters by other workers. Surely some standard should be adopted. The notation used in this paper is fairly complete and easy to type; I propose it as a standard.

DEFINITIONS

"INSTANTANEOUS (INDEPENDENT) RATES".—Independence, in this paper, means that a given mortality rate is not influenced by the magnitude of other mortalities occurring during the same period.

If fishing acts such that the ratio of the catch (in numbers) of a fishery is directly proportional to the available stock, during an instant of time, we have

$$\frac{dC}{dt} = pN_t$$

where "C" is the catch, "N_t" is the stock, and "p" is the rate of fishing.

If the death rate of fish from all other causes proceeds in the same fashion, the deaths in an instant being proportional to the stock in that instant, then

$$\frac{dB}{dt} = qN_t$$

where "B" is the number of all other (natural) deaths, and "q" is the rate of natural death.

The rate of total death, then, is the sum of the independent rates of mortality:

$$\frac{dD}{dt} = \frac{dC}{dt} + \frac{dB}{dt} = (p + q)\, N_t = iN_t$$

where "i" is the rate of total death and "D" is the total number of deaths from all causes.

"ANNUAL (DEPENDENT) RATES"—CONDITIONAL.—Conditional, as used here, means that the simple sum of this measure of the components of total mortality is not equal to the corresponding measure of total mortality rate.

Over the period of a year, or of a season,

$$m = \frac{c}{N}$$

where "c" is the number of fish that would be caught *if* the only deaths occurring were those due to fishing. "N" is the size of the stock at the beginning of that period, and "m" is the rate of fishing.

Similarly,

$$n = \frac{b}{N}$$

where "b" is the number of fish that *would* die naturally *if* the only deaths occurring were those due to natural causes, and where "n" is the rate of natural mortality.

"ANNUAL (DEPENDENT) RATES"—UNCONDITIONAL.—The "rate of exploitation" is "u" in

$$u = \frac{C}{N}$$

where "C" is the number of fish that die from fishing, although natural mortality may be going on at the same time ("C" is simply the catch).

[1] Published by permission of the Director, Fish and Wildlife Service, U. S. Department of the Interior.

The rate of natural mortality is "v" in

$$v = \frac{B}{N}$$

where "B" is the number of fish that die naturally although fishing may be going on at the same time.

The rate of total mortality is "a" in

$$a = \frac{D}{N}$$

where $D = C + B$.

Included above are the defined parameters. Those given below are derived from these definitions and require, during the derivations, certain assumptions about the time and space distribution of the defined parameters. These assumptions are included at the appropriate places.

Derivations

All the foregoing *dependent* mortality rates may be expressed in terms of the instantaneous (independent) rates as follows:

The total deaths, "D", may be evaluated in terms of the instantaneous rate, "i", by integrating the expression for the rate of accumulation of "D" over the time period for which one wishes to express the total death count. By definition, this total death count, expressed as a fraction of the initial population of the time period, is equal to "a".

Since

$$\frac{dD}{dt} = iN_t$$

$$= i(N - D_t)$$

So

$$\frac{dD}{(N - D_t)} = i(dt)$$

Now if "i" is constant during time "t",

$$(1) \qquad it = \int_0^D \frac{dD}{(N - D_t)}$$

and upon integration, $e^{-it} = (N - D_t)K$, where K is a constant. When $t = 0$, $e^{-it} = 1$, and $D_t = 0$, so $(N - 0)K = 1$, or $K = \frac{1}{N}$

(1) becomes

$$e^{-it} = (N - D_t)\frac{1}{N}$$

or

$$D_t = N(1 - e^{-it})$$

Since by definition

$$a_t = \frac{D_t}{N}$$

we have "a" in terms of "i":

$$a_t = 1 - e^{-it}$$

Since the stock at an instant is the same as the initial stock less the "D_t", we also have the expression for the stock size on time as

$$(2) \qquad N_t = Ne^{-it}$$

if "i" is constant during time "t".

This will be useful in the derivations to follow.

If fishing is the only cause of death, we have

$$\frac{dc}{dt} = pN$$

and if "p" is constant over time "t",

$$c = (1 - e^{-pt})N$$

from an argument identical to the derivation of "D".

Similarly

$$b = (1 - e^{-qt})N$$

if "q" is constant over time "t".

These two expressions give the relation between "p" and "m", and "q" and "n": since by definition,

$$m = \frac{c}{N}$$

then

$$m_t = 1 - e^{-pt}$$

and $n = \frac{b}{N}$, so $n_t = 1 - e^{-qt}$, if "p" and "q" are constant over time t.

The rates of dependent mortality can be ex-

pressed in terms of the instantaneous rates as follows:

$$\frac{dC}{dt} = pN_t$$

but

$$N_t = e^{-it}$$

so $C_t = \frac{p}{i}(1 - e^{-it})N$ for "t" from "0" to "1", after integration. Since, by definition,

$$u = \frac{C}{N}$$

then

$$u = \frac{p(a)}{i}$$

Finally, a very simple but very basic derivation is one regarding the derived proportionalities of fishing effort and the instantaneous fishing mortality rate. The latter has been defined above as

$$p = \frac{\frac{dC}{dt}}{N_t}$$

Thus it is the fraction of the population, at an instant of time, that is caught by the total fishing effort at that instant. Now in an instant, we may safely assume that the several units of fishing effort do not physically compete or entangle each other's gear, so each unit of effort should contribute equally to p, providing the unit of effort is taken as a standard, with the idea of equality in mind. Then each unit of such effort should have a ratio of catch in an instant to the stock in that instant of, say, Q, such that

$$p = Qf$$

where f is the number of standard fishing effort units. The assumption of Q being the same for each unit of effort can be substantially satisfied by such devices as comparing the performance of the several units of fishing effort, such as boats, during a season, when these units of effort are fishing the same stock density. Then, if Q is constant, the effective p to be expected from any size of f is predictable—a very useful situation in examining past fishing as well as predicting what to expect in the way of catches in the future.

Similarly for "B",

$$\frac{dB}{dt} = qN_t = qNe^{-it}$$

So

$$B = N\frac{q}{i}a$$

after integration for t from "0" to "1", and since, by definition,

$$v = \frac{B}{N}$$

then

$$v = \frac{q}{i}a$$

Assumptions necessary to the above derivations are that p, q, and i, be constant during the time that the deaths are occurring. If these rates are not constant, the resulting relations are different, of course, from those here derived. However, the instantaneous rates are seldom measured directly, but are deduced from the death counts. Therefore, the use of the above relations gives estimates of the instantaneous rates that would, if constant, yield the observed annual death rates. In a sense, then, the constant rates assumed to obtain will be average (or effective) instantaneous rates, or equivalent instantaneous rates, in the case when they are actually not constant during the time interval considered.

Discussion

Estimation.—In most fisheries, the only parameter that can be observed directly is the rate of exploitation, "u", and then only where the initial stock is known. The procedure of tagging or marking a number of fish and then observing them as they reappear in the catch is a common means of estimating (observing) "u" directly, since one then knows what the initial marked population is.

It is interesting that "p" can be shown to be equal to

$$p = \frac{C}{N}$$

TABLE I

NOTATION BY SOME FISHERIES WORKERS IN POPULATION DYNAMICS

Widrig (1954)	Ricker (1944)	Baranov (1918)	Beverton & Holt (In Press)	Clark (1945)	Thompson (1950)	DeLury (1947)	Schuck (1949)	Fry* (1949)	Russell (1942)	Herrington (1948)
p	p	k_2	F	..	..	d	..	..	..	..
q	q	k_0	M	..	..	..	..	r	..	..
i	i	k	..	..	..	..	..	..	..	..
u	μ	..	..	..	..	..	..	..	..	..
m	m	φ_2	..	F	..	..	..	..	..	..
v	ν	..	..	..	..	..	..	..	..	..
n	n	φ_0	..	N	..	..	..	..	..	..
a	a	φ	..	T	..	..	..	..	..	..
s	s	..	..	..	R	..	..	..	..	..
b	..	..	..	..	..	..	..	..	..	..
B	..	..	..	..	..	..	N	R	M	M_n
c	..	..	..	..	..	..	..	..	..	..
C	..	..	..	..	C	c, K	C	..	C	M_f
D	..	..	..	..	..	..	..	D	..	..
N_t	N_t	..	...	..	..	..	..	..	..	..
N	N_0, N	n	..	..	A, S	N(0), N(1) N	S	..	S_t	P_t
$\bar{N}$	$\bar{N}$	..	..	..	..	..	..	..	..	..
f	f	..	..	..	f	e, E	..	..	..	..
Q	..	..	..	..	r	k	..	..	..	..
C/f	..	..	..	..	c	C	..	..	..	..

* Same as DeLury, except as noted here.

where "C" is the catch, and $\bar{N}$ is the *average*, not initial, stock during the time period considered.

Also

$$\frac{C}{p} = \bar{N} = \frac{C}{Qf}$$

So

$$\frac{C}{f} = Q\bar{N}$$

Since the instantaneous rates are independent of each other, they are convenient to use. But since the average population is difficult to observe, "p" will seldom proceed directly from observational data.

Although "a", "u", and "v" have rather good intuitive implications, it is difficult to observe "m" and "n", in practice.

The following table compares the notation used here with a sample of that used by others. The list is by no means complete, but illustrates the diversity of notation for identical parameters.

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Variation in Topotypes of the Salamander *Plethodon jordani melaventris*

THELMA HOWELL AND ANN HAWKINS

IN the course of a detailed study of the *jordani-metcalfi* group of the genus *Plethodon*, Pope and Hairston (1948) deemed it advisable to name two populations: (1) *Plethodon shermani rabunensis*, known only from Rabun Bald Mountain, Rabun County, Georgia, and (2) *Plethodon shermani melaventris*. The latter population was reported as ranging from Swan-

nanoa, Buncombe County, North Carolina, southward into Greenville County, South Carolina, and westward to Highlands, Macon County, North Carolina. In effect, the name *melaventris* was assigned to the southern segment of a group designated as *metcalfi* by Brimley (1912), and long regarded as ranging from southwestern Virginia south through western North Carolina, northern Georgia, and northeastern Alabama (Stejneger and Barbour, 1943). It also meant splitting the *clemsonae* of Grobman (1944) into three subspecies.

Subsequently Hairston and Pope (1948) studied fresh material, analyzed and then synthesized the geographical distribution of various characters, notably color, and proposed that the immaculate black-bellied population south of the Balsam Mountains and Swannanoa River constitute the *P. s. melaventris* group, and that the immaculate, pale-bellied population north and east of *melaventris* retain the name *P. metcalfi* as proposed by Grobman (1944). A detailed study of intergradation in the *jordani* and *metcalfi* groups by Hairston (1950) led him to conclude that the plethodons *P. s. melaventris* and *P. s. rabunensis* are best considered as subspecies of *P. jordani*.

Pope and Hairston (1948) named as the type of *melaventris* a male (Chicago Natural History Museum No. 47614) from Highlands, Macon County, North Carolina. This specimen was described as "116 mm. in length, 60 mm. from snout to anterior angle of the vent; 14 costal grooves; vomerine teeth 10–11. The body is immaculate black above and below; the throat is gray. The limbs like the body in color." One hundred and twelve paratypes "exhibit no significant variation" (*op. cit.*: 107).

The above description is not adequate as a basis for studies now in progress by several investigators whose researches are concerned with the distribution and intergradation of certain members of the *jordani* group in marginal areas. The investigation reported here is an analysis of the characters of one hundred and thirty-eight topotypes of *melaventris* with a description of significant variations.

Materials and Methods

The specimens used in this study were collected at random during the day and night. One short evening period yielded 29 specimens, picked up while walking along the dam at Lake Ravenel and along a road above the north bank of the lake. The living animals were studied, killed with chloretone, and hardened in formalin.

The anterior angle of the vent was used in making the snout–vent measurements. Tail length was obtained by subtracting snout–vent measurement from total length, the latter made by laying the animal along a ruler. The nearest whole number was taken as the reading.

Most of the specimens are deposited in the Museum of Natural History of The Highlands Biological Station, and are numbered as follows: HBS 16.1-38; HBS 17.1-38; HBS 18.1-13; HBS 19.1-27.

Analysis of Characters

Size.—One hundred and thirty-eight specimens ranged in total length from 44 to 149 mm. From snout to anterior angle of vent, the range was 27–78 mm. When the series was arranged on a histogram (Fig. 1), the first-year individuals were somewhat separated from the

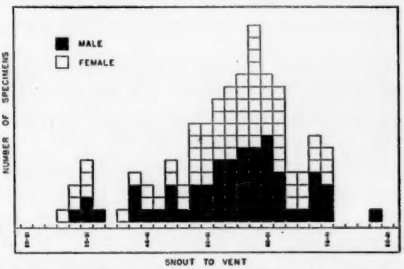

Fig. 1. Size (snout–vent length in mm.) distribution of 138 specimens of *Plethodon jordani melaventris*.

remainder of the specimens. There were no clear-cut divisions for other age groups.

Costal Grooves.—The method of maximum counting (one each for the axilla and groin) was used to determine the costal groove count of 112 individuals (Table I). One specimen had 14 grooves; 92 had 15; 2 were asymmetrical with a 15–16 count; and 17 specimens had 16. In the description of *P. s. melaventris*, Pope and Hairston (1948) gave 14 as the costal groove count of the type and no variations were noted.

In a more recent paper dealing with *P. ouachitae*, Pope and Pope (1951) pointed out

TABLE I

NUMBER OF COSTAL GROOVES IN *Plethodon j. melaventris*

Costal groove count Pope and Pope (1951) method	Male	Female	Total	Maximum count method
13-groove group				
12 + 1 and 12 + 1.....	..	1	1	14
13 and 13.....	6	2	8	15
13- and 15-groove group (asymmetrical)				
13 and 13 + 2.....	..	1	1	15; 15
14-groove group				
13 + 1 and 13 + 1.....	24	28	52	15
14 and 14.....	5	8	13	16
14- and 15-groove group (asymmetrical)				
13 + 1 and 13 + 2.....	2	2	4	15
13 + 1 and 14 + 1.....	..	1	1	15; 16
14 and 13 + 2.....	..	1	1	16; 15
15-groove group				
13 + 2 and 13 + 2.....	8	19	27	15
14 + 1 and 14 + 1.....	2	2	4	16

the difficulties inherent in the usual methods of counting costal grooves and the need of a method which would show intraspecific variation in groove structure. By the method of maximum count, 82.1 percent of our topotypic material shows a groove count of 15; 15.1 percent, a count of 16; and the remainder are asymmetrical with a count of 15–16. If the Pope and Pope method is used, 8 percent of the specimens are in the 13-groove group, 58 percent in the 14-groove group, and 27.8 percent in the 15-groove group.

VOMERINE TEETH.—Vomerine teeth were counted in 113 of the 138 specimens. Considerable variation in the number occurred. In three of the males, the lowest counts were 5–4, 4–5, 4–5 (figures indicate counts on right and left sides, respectively); and the greatest, 12–15, 12–14, 13–11. The average total number of teeth for the males was 17.5. Among the females the lowest counts were 4–4, 4–5, 4–4; and the greatest, 12–13 (three individuals), 12–12, 12–11. The average total count for the females was 18.2. The extremes for both sexes, as well as the averages, show a high degree of consistency for such a variable character. Pope and Hairston (1948) gave 10–11 as the vomerine count for the type specimen.

There was no significant correlation between total number of vomerine teeth and size of the individual. Among the males the smallest individual (29 mm. snout to vent) and one of the largest (68 mm.) each had a count of 13. The two smallest females (27 and 28 mm. snout to vent) had counts of eight. On the other hand, five females with a snout–vent length of 58 mm. had counts of 12, 16, 18, 20 and 24; but one 40-mm. female also had a count of 12, and a 38-mm. female also had 20. The highest count for females (25 teeth) was observed at snout–vent lengths of 53, 65 and 67 mm.

COLOR.—Color pattern as a diagnostic character of members of the *jordani* and *metcalfi* groups has been the subject of considerable study (Pope and Hairston, 1948; Hairston and Pope, 1948; Mittleman, 1948; Hairston, 1950). In the work reported here, great care was taken to record the description of the color patterns of living animals.

There was no variation in the dorsal coloration of the specimens. The description of "bluish plumbose above" given to *P. metcalfi* by Brimley (1912: 138) adequately describes the back of *melaventris*. There was no noticeable difference in the blue-black color of the back and sides in the entire series.

The coloration of the head is the same as that of the back. The cheeks of 15 specimens had a definite gray-white color, separating these individuals from those whose cheeks were the same color as the back and top of the head.

Variation in the belly color of "metcalfi" salamanders has been noted by several investigators (Bailey, 1937; Grobman, 1944; Pope and Hairston, 1948; Hairston and Pope, 1948; Hairston, 1950). Differences in opinion have been influenced to a large extent by lack of agreement as to what is meant by the terms "light gray," "dark gray," and "black." Hairston (1950), in considering the problem of intergradation, made a comparative study of the belly color of *metcalfi–jordani* salamanders in the Southern Appalachians, and, primarily on the basis of that work, gave subspecific status to the dark-bellied (*P. j. melaventris*) and light-bellied forms (*P. j.*

metcalfi). He noted that "there is much variation in belly color among specimens from any given locality" (*op. cit.*: 268).

Since Hairston regarded the top of the Balsam Mountains as approximately the center of the zone of intergradation between *metcalfi* and *melaventris*, it seemed advisable to collect fresh material from marginal areas for comparative purposes. Series were collected from Beech Gap (the area of intergradation of *melaventris* and *metcalfi*), from Pisgah Forest near Looking Glass Falls, from Mt. Toxaway, from Whiteside Cove (Jackson County), and from Cowee Bald. The observation of Hairston (1950), that considerable variation exists in belly color among specimens from any given locality in the southern range, was verified in all the series listed here.

In the topotypic series of *melaventris*, 94 percent of the specimens fell into a color group ranging from light gray to very dark gray, most of them being a medium gray. Only 5 percent of the specimens could be said to have a black belly such as described for the type specimen. Four specimens were mottled black-on-white, one of them having a center line of black from which grayish streaks radiated and lessened to the sides. In two others, unpigmented areas were spread over the venter, and in another the melanophores were lacking between and above the forelimbs. Thus, considerable variation exists in the belly color of topotypic specimens of *melaventris*.

Color of the throat varied from light to dark gray and might be regarded as a much paler continuation of the color of the belly. There was variation here, however, as 11 of our specimens were gray-on-white in color, giving a somewhat mottled effect.

Dorsally, the legs were pigmented like the back, and ventrally, like the belly. They had no distinguishing spots, red pigment, or brassy flecking.

In color pattern, juveniles did not depart from that of adults. One juvenile had white spots on the cheek.

Since the white spots on the cheeks and on the sides of the trunk in *rabunensis* is one of the diagnostic characters used in separating it from *melaventris* (Pope and Hairston, 1948), it is pertinent to note that 18 of the topotypic specimens of *melaventris* had white spots distributed as follows: belly (2 specimens); sides (1); cheeks (3); venter (3); throat and cheeks (1); cheeks and sides (2); head and back (1); back and sides (1); throat, belly, tail (4).

Sexual Maturity and Sexual Dimorphism

Since the presence of cloacal gland papillae and mental gland denote sexual maturity of the male, a correlation between length and these characteristics is a good index to length at maturity (Fig. 2). Up to 49 mm. (snout–vent length) neither character was evident; at 49 mm. and above, one or both of the characters

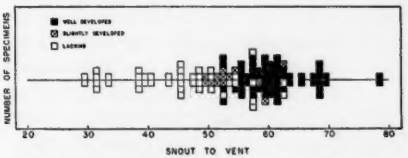

Fig. 2. Development of mental gland (above line) and cloacal papillae (below line) in relation to snout–vent length (in mm.) in 59 males of *Plethodon jordani melaventris*.

(in most individuals both characters) were present; in a single exception, the condition was discovered when the sex was noted in connection with studies on breeding habits reported below. In two of the 45-mm. specimens the testes were very small. In one 48-mm. and one 52-mm. specimen the testes were of medium size. One 62-mm. specimen had large testes but a slightly developed mental gland, while a 57-mm. specimen had large testes and a very large mental gland. It appears that at 50 mm. male specimens have reached sexual maturity.

The longest male, snout to tail tip, was 145 mm., the mean length of the series being 110.4. In snout–vent length 62 males varied from 29 to 72 mm., the mean being 54.8. The series of 76 females ranged in total length from 44 to 150 mm., the mean being 111.3. From snout to vent the females ranged from 27 to 72 mm., the mean being 54.3. There is no significant difference in the sizes of the sexes.

Both males and females have naso-labial grooves, those of the male being more pronounced. Because the male snout is swollen at these grooves, the head has a blunt appearance. In contrast the female snout is more pointed.

The series of 138 specimens is composed of

62 males (45 percent) and 76 females (55 percent).

Reproduction

Twenty-two of the females were examined for eggs. In nine specimens, ranging in size from 29 to 53 mm. in snout-vent length, immature egg masses were found. In the remaining 13, ranging from 55 to 69 mm., eggs were in varying stages of development. In three of these the eggs were poorly developed, while in two (55 and 68 mm.) the eggs were large with a gelatinous covering. It should be noted that, while the specimens considered here were collected in July and late September, immature as well as large eggs were found in both months. These findings suggest that the laying season is an extended one. Egg complements of seven specimens ranged from 64 to 137, the average being 94.7.

Testes from six males collected in July were prepared for histological examination and carefully studied. In all specimens, the testes showed mature or nearly mature sperm.

Acknowledgments

The specimens used in this report were obtained with the assistance of many different persons in residence at the Highlands Biological Station. This assistance is gratefully acknowledged. The junior author received a grant from the Margaret Cannon Howell Fund administered by the Highlands Biological Station, and without that aid this study would not have been possible. Mr. J. C. Knepton, Jr., gave valuable assistance in the histological study of the gonads.

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Social Patterns in the Leptodactylid Frogs *Syrrhophus* and *Eleutherodactylus*

David L. Jameson

Considerable variation has been found in and between species of anurans with regard to breeding time, breeding locality, habitat preference, call, clasping mechanism and pattern, egg deposition, and method of egg development. The first six factors have been considered as possible isolating mechanisms between species of amphibians (Blair, 1941, 1943, and others). The last two have been used in taxonomy, although not always successfully, to separate species, genera and even families. Thus it becomes of interest to examine the available information about the breeding activity of any amphibian species in an attempt to establish the types and modes of these breeding phenomena and to speculate on their possible origin. The following observations were made in the course of work on the

life history of *Eleutherodactylus latrans*, the barking frog, and *Syrrhophus marnocki*, the cliff frog.

The peak of breeding activity, as indicated by numbers of individuals calling and by numbers of individuals with eggs, is approximately the same (April and May) in the two forms. Both forms are active at any time of the year when there is sufficient ground moisture. Both breeding and general activity are apparently in response to the same, or at least comparable, sets of environmental conditions. The ranges of these species are widely sympatric (northern México, Central and Trans-Pecos Texas), and their habitat preferences, if not identical, are at least congruent.

Both forms have what might be referred to as a typical or normal call. The dog-like bark of *Eleutherodactylus* has been heard from February to August; the cricket-like call of *Syrrhophus* is heard throughout the year. *Eleutherodactylus* apparently has a warm-up call which is voiced crepuscularly and which changes rather abruptly to the normal bark as darkness falls. It appears that the difference between the two calls is not due to any change in acoustics after dark. A chorus of these amphibians emitting their calls may be likened to an orchestra tuning up before the concert. *Syrrhophus* demonstrates no comparable phenomenon.

When grasped by a human hand the female of *Eleutherodactylus* often will emit a blaring screech which is quite startling, even when expected. The female of *Syrrhophus* apparently has no call at all.

There is present in *Eleutherodactylus* a very complex pattern involved with the response call of local individuals to that of a leader. This leader appears to be the frog with the loudest voice in the area. If the stronger-calling individual is disturbed enough to cease barking, another soon takes the initiative and is in turn, followed by the weaker-voiced ones. However, if the source of disturbance is removed, the first leader, presumably assuming the danger past, begins to call again. The leader and "sub-leader" then engage in what might be considered a duel of voices until the weaker calls again follow those of the original leader. K. P. Schmidt (personal communication) has noted similar activity, and local residents have informed me of like phenomena in choruses of this species. *Syrrhophus* shows a similar social pattern, but the groups are composed of only three or four individuals rather than the complex hierarchy of over a dozen in *Eleutherodactylus*. Also in *Syrrhophus*, when the local leader ceases to call, so do all the other individuals, and they rarely call again until he resumes. The different patterns of *Eleutherodactylus* and *Syrrhophus* may be correlated with the volume of their calls; the former can be heard (by the average human) from over a mile away while the cliff frog is inaudible beyond about 100 feet.

Syrrhophus has, additionally, a rather striking call characterized by its rapidity, clarity, and sharpness, which it voices only during the height of the breeding season. When this call is traced to its origin, one finds either a clasping pair (the male continuing to call even when clasping) or a male with a female nearby. *Eleutherodactylus* has no comparable breeding call.

Eleutherodactylus is difficult to observe in the field, and attempts at laboratory breeding have met with little success. Forced clasping produces an axillary response. A pair of barking frogs was observed under one rock for three nights. The male called each night but the pair did not mate. This behavior suggests a long and possibly complex mating pattern. As previously reported (Jameson, 1950), when mating does occur the eggs are laid in a cluster in a small cavity in the soil under a rock. The male remains with the eggs and apparently maintains the necessary moisture conditions by excretion.

The cliff frog has been observed to court, mate, clasp, and lay eggs in the laboratory. The male *Syrrhophus* approaches the female, scratches her back, neck and legs with his hind legs, and, if the female does not jump away, will then complete an axillary clasp. The male continues to stimulate the female by use of his hind legs. After some time the female begins to dig a trench with her forelegs and deposits the eggs as the pair moves along it. Both individuals utilize their hind legs to cover the eggs as they move, and the entire process of laying eight to twenty eggs takes little more than 20 minutes. There is no evidence that either individual remains with the eggs.

The comparable breeding times, localities

and habitats, as well as the method of egg deposition of the two species are certainly related to their environmental adaptability. The method of development may be the result of a common ancestry, or, since direct development is a phenomenon found in some species of a majority of the families of amphibians (Orton, 1949), may be a response to environmental conditions.

The complex pattern found in both call and clasping may be of much more common occurrence than has been thought previously to be the case in either these or in other genera. Since some of these call patterns are found throughout the year and not just in or during the breeding season, it is difficult to believe that they are entirely breeding phenomena; however, their origin may be linked with the development of the breeding patterns.

At present it can only be assumed that these patterns arose independently in response to the typically terrestrial habitat in which these forms occur.

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Further Observations on Reproduction in the Lizard *Xantusia vigilis*

Malcolm R. Miller

During the summer of 1952 a collection of *Xantusia vigilis* was made for embryologic and histogenetic studies. In the course of gathering this material, observations were made on the dates and length of gestation, the number of young carried by each female, the distribution of young in the oviducts, the ovarian distribution of corpora lutea, and parturition in the laboratory. This information is compared and combined with similar data derived from studies made during the summers of 1940 and 1941 (Miller, 1951) in the same area (Tables I and II).

All animals were collected in a small area near Palmdale, California. I would like to state, lest I be considered improvident in taking such a large number of these lizards (see Cowles, 1952), that the Joshua tree area in which I collected was in the process of being bulldozed for the establishment of chicken ranches.

Ninety-six animals were studied: 6 pregestational, 57 gestational, and 33 postgestational. Forty-three females delivered young in the laboratory.

Two is the most frequent number of young produced by *Xantusia vigilis*. Also, there is a preference for the right oviduct when only one ovum is ovulated, and for the right ovary to produce a greater number of mature ova. This tendency is possibly associated with the relatively greater space in the right side of the abdomen due to the disposition of the liver and upper intestinal segments.

The time of onset of gestation in *Xantusia vigilis* is dependent in part on climatic factors (Miller, 1951). The spring of 1940 was relatively dry, and most ovulations occurred during the first 10 days of June. There was considerably more rain and lower temperatures in the spring of 1941, and the time of ovulation was later, extending from the middle of June to the middle of July. The 1952 breeding season was preceded by a relatively wet spring, and observations revealed that the majority of ovulations occurred during the last 10 days of June and the first week of July.

During the summer of 1951 an attempt was made to collect a series of *Xantusia* embryos. However, of the first 36 large and sexually

mature females (having a snout–vent length of over 41 mm.) only two were gravid. The other 34 had either begun resorption of incompletely developed ova or had never achieved any degree of yolk deposition. The markedly depleted fat bodies of these nongravid females denoted a relatively poor state of nutrition which probably accounted for the failure to produce mature ova. The spring of 1951 was very dry in this area and had been preceded by a number of dry years. (The author has observed a similar situation in *Triturus torosus*. Females in a relatively poor state of nutrition, as indicated by depleted fat bodies, usually have deposited no ovarian yolk and fail to breed.) Hence, the ability to deposit yolk and produce mature ova is dependent in part on an adequate nutritional status. This in turn is dependent on climatic factors which play a role in the relative abundance of food. Males of *Xantusia vigilis*, on the other hand, had all obtained a state of testicular maturation in 1951, despite a relatively poor nutritional status.

Although the majority of the individuals of *Xantusia vigilis* in the Fairmont and Palmdale areas of the Mojave desert apparently failed to reproduce during the relatively dry year of 1951, dissections of at least six mature females each of *Uta stansburiana hesperis*, *Scleoporus magister magister*, *Callisaurus draconoides gabbi*, and *Cnemidophorus tigris multiscutatus* from the same area, revealed adequate nutrition and normal ovarian activity. Hence, the dry year in question (1951) apparently affected *Xantusia* selectively. The reasons for this probably are differences in food habits.

As stated above, most females ovulated from June 20 to July 7, 1952. Forty-three gravid individuals were captured on August 10, 1952 and maintained in the laboratory in large sandy bottomed finger bowls at temperatures ranging from 75° to 90°F. As has been found most practical with laboratory maintained *Xantusia vigilis*, each animal was force fed lean beef twice weekly. Excellent nutritional condition is obtained by this method. Although *Xantusia* will readily eat termites and fruit flies in captivity, sufficient quantities of these were not available.

In the laboratory, the first births occurred on September 15, 1952. For the subsequent 22 days (until October 7), at approximately daily intervals, 25 females (of 43 gravid animals) gave birth to 41 young. Thirty-six young lived and five succumbed because of apparent failure to free themselves from the extraembryonic membranes. As stated by Cowles (1944), the mother usually eats the membranes, but sometimes (probably because of the artificial environment) they were not consumed. Births occurred with equal frequency during both the day and night. Parturition occurs in less than 10 minutes. This observation agrees with those of Cowles (1944).

The gestational period for 1952 was the interval from ovulation (June 20 to July 7) to the time of presumably normal deliveries (September 15 to October 9). The normal length of gestation, then, was approximately 90 days—perhaps somewhat less, but certainly not longer. This corroborates the observations made during the breeding seasons of 1940 and 1941 (Miller, 1948).

After October 9, it was apparent that abnormally long retention was occurring in the remaining 18 undelivered females. From Octo-

TABLE I

NUMBER OF YOUNG PRODUCED BY *Xantusia vigilis* AND THEIR OVIDUCAL DISTRIBUTION

Years studied	Number of animals	Number of young			Oviducal distribution			
		1	2	3	1 in right	2 in right	1 in each	2 in right and 1 in left
1940 and 1941	78	17	60	1	17	1	59	1
1952	70	6	61	3	6	0	61	3
Total	148	23	121	4	23	1	120	4
Percentage of total	....	15.5	81.7	2.8	15.5	0.7	81.1	2.7

TABLE II

DISTRIBUTION OF CORPORA LUTEA IN THE OVARIES OF *Xantusia vigilis*

Years studied	Number of animals	1 in right	1 in left	2 in right	2 in left	1 in each	3 in right	2 in left and 1 in right
1940 and 1941	77	13	4	20	7	32	1	0
1952	68	6	2	13	8	36	1	2
Total	145	19	6	33	15	68	2	2
Percentage of total	....	13.1	4.1	22.8	10.3	46.9	1.4	1.4

ber 9 to October 15, eight females delivered 13 dead young and three delivered five weak ones. In order to determine the possible cause of fetal death, five gravid females were sacrificed on October 15. In each one, two fully developed young were found dead within the oviducts. Two remaining gravid animals delivered dead young on October 22, and October 27, 1952.

Thus, one may conjecture that if the young of *Xantusia vigilis* are retained in utero beyond a certain period, they will expire and probably be expulsed within a month. The cause of fetal death is possibly due in part to the inability of an aging placenta to meet the increasing oxygen demand of a growing organism and failure of excretory mechanisms. The abnormal conditions of the laboratory probably account for oviducal retention of young, as it is presumably a rare occurrence in nature.

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The Salamander *Plethodon richmondi* in Southwestern Ohio

William E. Duellman

For several years I have collected and observed *Plethodon richmondi* Netting and Mittleman in southwestern Ohio. During this time I have accumulated data pertaining to the life history and ecology of these salamanders. In many respects these data are not complete, but since the area of study is no longer easily accessible to me, it seems advisable to present the following information at this time.

Plethodon richmondi has been found in several localities in southern Ohio; it is not common, though it may be locally abundant. The observations and measurements presented in this paper are based on specimens from Brown, Clark, Champaign, Greene, Miami, Montgomery, and Warren counties in southwestern Ohio. However, most of the specimens are from an area known as Glen Helen near Yellow Springs in Greene County.

Habitat.—*Plethodon richmondi* is strictly an inhabitant of woodlands. The common name, ravine salamander (coined by Netting), is quite appropriate, as wooded slopes appear to be a favorite habitat. The habitat at Glen Helen appears to be typical, and so I shall describe this in some detail. At this locality there are several small ravines from which streams flow into the Little Miami River. Limestone outcroppings of Cedarville and Springfield dolomites form the rims of the ravines. From the base of these outcroppings extending downward to the stream beds are wooded talus slopes. The soil is a rich loam and fairly well drained. Many slabs of limestone from the higher outcroppings lie upon, or are imbedded in, the soil. At the foot of the slopes there are often small, temporary and permanent springs. There are good stands of hardwoods on these slopes. The dominant trees are elm (*Ulmus*), oak (*Quercus*), and shagbark hickory (*Carya ovata*). Scattered among these are redbud (*Cercis canadensis*), dogwood (*Cornus florida*), basswood (*Tilia americana*), maple (*Acer*), and ash (*Fraxinus*). There is little underbrush and few herbaceous plants but, in most places, the ground is covered with a thick layer of leaves and humus.

At most of the localities where *P. richmondi* has been collected the habitat is quite similar to the one described above. However, at Sunderland Falls in Montgomery County and in a narrow ravine in Miami County the herbaceous layer and underbrush are better developed, while near Ripley in Brown County these salamanders were found on a drier and more exposed hillside.

GENERAL HABITS.—Field studies have revealed that *Plethodon richmondi* is active throughout the year except in the hot, dry summer months. It has been commonly found from late September to early July, while very few were observed in the intervening period. These salamanders are most easily found and are most active in October and early November and again in the early spring. At these times, as many as three or four individuals may be found under a single rock. When uncovered, they either move quickly into the leaf litter or attempt to bury themselves in the soft soil. They are also active to some extent in the winter months. On several occasions I have found them when the air temperature was below freezing, and there was snow on the ground. In the winter they are most commonly seen during thaws when the ground is soft. At these times, they may be found under limestone rocks imbedded in the talus slopes. Individuals taken during cold weather are usually quite lethargic and make very little attempt to move when they are uncovered. At all times of the year they are found much more commonly under rocks than under logs or bark. Only about one out of every twenty specimens was found under logs or bark. This indicates a definite cover preference in contrast to *Plethodon c. cinereus* which is found under logs as often as under rocks.

On March 5, 1950, twelve individuals were found buried in clay beneath a limestone outcropping. These showed no activity whatsoever and were undoubtedly hibernating. The temperature of the clay was 48°F. Nine of these were small individuals and were found in a tight cluster. It is possible that these were late hatchings and that, after they emerged from the eggs, they remained at the nest site to hibernate.

Other species of reptiles and amphibians commonly found with *Plethodon richmondi* are *Plethodon c. cinereus*, *Eurycea bislineata rivicola*, *Eurycea l. longicauda*, and *Rana clamitans*. I have also found *Bufo terrestris americanus*, *Rana palustris*, *Diadophis punctatus edwardsi*, and *Lampropeltis doliata triangulum* associated with *richmondi*. At two localities in Montgomery County *Plethodon c. cinereus* and *Plethodon richmondi* are found to inhabit the same wooded slopes. However, in most of the other localities where *richmondi* is common, *cinereus* is absent. In the late spring when the small streams often overflow their banks, *Eurycea l. longicauda* leaves its usual streamside habitat to take refuge on the slopes of the ravines. At these times it is found under the same shelter as *P. richmondi*. In rainy weather, *Eurycea bislineata rivicola* may also be found under the same cover as *P. richmondi*. The stomachs of the snakes collected in areas inhabited by *Plethodon richmondi* were examined, but none of them yielded salamanders. *Diadophis* is known to feed upon salamanders, and since it is often found in the same habitat as *Plethodon richmondi*, it is quite likely that the latter falls prey to this snake.

FOOD.—There has been no mention of the food habits of the salamanders of the *richmondi-nettingi* group. I have examined the stomach contents of thirty-two specimens collected at various times of the year and ranging in size from juveniles with a snout-vent length of less than 20 mm. to large adults (Table I).

Ants occurred most frequently and made up the greatest bulk percentage of the food. The sow bug (Oniscidae) was the next most common food item found. These two items, along with various small ground beetles, comprised over fifty percent of the food of the specimens examined.

Mr. John T. Wood has turned over to me data on the stomach contents of twenty-eight specimens of *P. richmondi* in his collection. These data support my results in that ants constitute the greatest percentage of the food and sow bugs the next greatest. Items found by Wood that were not present in specimens examined by me are: one house fly, one centipede (?) one flatworm, and one small, black bee. (Wood's observations are not included in Table I.)

There is considerable variation in the amount and size of materials contained in the salamanders' stomachs. One specimen with a snout-vent length of 42 mm. contained an earthworm (*Lumbricus*) nearly 50 mm. in length. In another specimen with a snout-vent length of 49.0 mm., a helicid snail with a shell 3.0 mm. in diameter was found. Some of the specimens had only one kind of food in their stomachs. Four specimens contained only ants,

TABLE I

SYNOPSIS OF FOOD FOUND IN *Plethodon richmondi*

Food item	Frequency of occurrence	Percentage of total bulk
ANNELIDA		
Lumbricidae	3	7.3
MOLLUSCA		
Helicidae	2	4.5
Limacidae or Philomycidae	4	4.3
Pupillidae	2	1.9
ARTHROPODA		
Crustacea		
Oniscidae	12	15.6
Unidentified	1	.2
Insecta		
Collembola		
Entomobryidae (Larvae)	5	2.3
Orthoptera		
Blattidae	1	.3
Hemiptera		
Unidentified	4	1.7
Hymenoptera		
Formicidae	20	21.4
Coleoptera		
Chrysomelidae	1	.2
Cucujidae	1	.3
Elateridae	1	1.1
Scolytidae	1	.5
Staphylinidae	4	2.1
Unidentified	4	7.9
Diptera		
Chironomidae (adult)	1	.3
Chironomidae (larvae)	1	.1
Empididae (larvae)	5	1.4
Unidentified	1	.3
Arachnoidea		
Araneida	8	4.4
Pseudocsorpionida	2	.2
Acarina	3	1.9
Unidentified Material (Decomposed animal material, plant material, and inorganic particles)	20	19.8

three contained only earthworms, one contained 16 sow bugs, and another contained only a land snail. On the other hand, a few specimens contained a large amount of food of great variety. In the way of examples, one specimen with a snout–vent length of 48.5 mm. contained one slug, two ants, one adult chironomid fly, one larval empidid, three beetles, one collembolan, one roach, four mites, one spider, and two crustaceans. Another individual with a snout–vent length of 39.5 contained one slug, 17 sow bugs, two ants, two larval empidids, and one hemipteran. Wood found as many as 43 ants in one stomach and 43 sow bugs in another.

In several stomachs small pieces of twigs and leaf particles were found. Also, small pieces of smooth, round rock were occasionally found in the stomachs. Undoubtedly this material, along with the plant particles, was accidentally ingested.

In comparing the food items found in the stomachs of the specimens collected in the winter months and those collected in the warm months, the following differences were noted: (1) sow bugs (Oniscidae) were not present in winter-collected specimens; (2) the larvae of entomobryids, empidids, and chironomids were not found in those specimens collected in the winter; (3) the food during the colder months consisted mostly of ground beetles, ants, spiders, slugs, and land snails.

In some respects, the food habits of *Plethodon richmondi* are similar to those of *Plethodon c. cinereus*. Hamilton (1932: 85) stated that *cinereus* feeds mostly on ants. Small beetles and lepidopterous larvae also constituted a large percentage of the food in the specimens he examined, while sow bugs made up a smaller portion, and snails were only occasionally found.

From these observations of the food habits of *Plethodon richmondi*, it may be concluded that (1) ants and sow bugs constitute the greatest part of the diet; (2) these salamanders forage either at night or beneath rocks and logs and in other subterranean situations in the wooded areas in which they live; (3) the salamanders feed throughout the winter, at which time the food items are more limited; (4) the size of a food item eaten or the amount of food eaten is dependent primarily upon the size of the salamander.

Netting (1939: 50) mentioned the tail enlargement of spring-collected specimens in comparison with those found in the fall. I have observed that the tail is most noticeably enlarged from late March through June. During this

period it is cylindrical and of approximately the same diameter along the proximal half of its length. The tail in specimens collected in September and October is considerably thinner. During the winter there is a gradual increase in the diameter of the basal half of the tail. This may indicate that *Plethodon richmondi* feeds more actively in the winter than in the summer, and that there is a seasonal difference in physiological response.

EGGS AND JUVENILES.—The literature reveals little on the eggs and juveniles of *Plethodon richmondi*. The only reference to the eggs is that of Wood (1945: 206–10), who described the ovarian eggs at various times of the year and stated that *richmondi* probably deposits its eggs in May. My observations bear out Wood's findings in that large ovarian eggs (2.0–3.5 mm. in diameter) were found in females in March and April. These large eggs are absent in the females collected in summer and autumn. However, very minute eggs may be found at any time of the year. These increase in size after the summer aestivation period, the growth continuing throughout the winter until deposition takes place in the spring, probably during May.

On July 14, 1949, Doyt Ladd found a clutch of 12 salamander eggs beneath a limestone slab on a talus slope at Glen Helen. The coherent eggs were found in a slight depression beneath the rock; they were not suspended by a stalk, and there was no common external envelope. That these are the eggs of *Plethodon richmondi* cannot be proven, since there was no attending female. The eggs of *Plethodon c. cinereus* are similar to the ones found, but that salamander is unknown in the area. Only two other salamanders (*Eurycea bislineata rivicola* and *Eurycea longicauda longicauda*) are known from this area, and both of these species lay their eggs in aquatic situations and at a much earlier date.

These eggs, collected by Ladd, were probably laid individually and then adhered to one another. They are unpigmented. The yolk is encased by a vitelline membrane plus two separate, clear envelopes external to it. The inner of these is considerably thinner than the outer. The diameter of the outer envelope in an average-sized egg measures 5.0 mm.; that of the vitelline membrane, 4.0 mm., and that of the yolk, 3.5 mm. The eggs had begun to develop, and a dorsal view of the embryo shows clearly the distinction between the head and the trunk. In some of the embryos the eyes and limbs are visible.

TABLE II

A SUMMARY OF THE MEASUREMENTS OF THIRTY JUVENILES OF *Plethodon richmondi*

All measurements are in millimeters

	Total length	Snout–vent length	Head length	Head width
Mean	28.6	17.8	4.9	2.9
$\pm\sigma$	±10.43	± 1.31	±.30	±.21
Range	25.0–34.5	16.0–20.5	4.1–5.7	2.3–3.2

At the time of their description of *Plethodon richmondi*, Netting and Mittleman had one juvenile specimen. This individual, collected in October, measured 23.0 mm. in total length and very likely was a recent hatchling. I have examined thirty juvenile specimens collected in the spring of 1950 (Table II).

The color of freshly preserved juveniles is quite similar to that of the adults. They are black above with a slight tendency toward brown middorsally. On the dorsum there are small, scattered, bluish-gray flecks barely visible to the naked eye. The flecks on the flanks are larger and more numerous so as to give a mottled gray appearance. The dorsal flecks are most apparent on the head, but they are also present on the upper surfaces of the limbs and on the anterior third of the tail. The belly is a light mottled gray.

SIZE AND GROWTH.—The smallest individual that I have examined had a snout–vent length of 16.0 mm. and a total length of 25.5 mm. The largest specimen examined is a female with a snout–vent length of 72.0 mm. and a total length of 138.0 mm., while the largest male examined measured 127 mm. in total length. The majority of the large specimens examined are females.

In large individuals the tail makes up a greater percentage of the total length than it does in the smaller ones. The mean tail/total percentage of sixteen juveniles is 38.1 percent, that of ten half-grown individuals is 46.1 percent, and that of ten adults is 50.8 percent. I can find no marked sexual dimorphism in body and tail proportions.

In very small specimens the legs are much longer in proportion to the body than in large ones; thus, leg length determines the number of costal grooves between the adpressed limbs. This number varies from two in the smallest specimen to eleven in two large individuals. (Table III; Fig. 1.)

The head is also proportionately longer in the juveniles than it is in the adults. In a series of sixteen juveniles the head length/snout-vent length is 27.5 percent; in a series of ten half-grown specimens this proportion is 23.8, and in a series of ten adults 20.9. In these same three series the head width is 58.9 percent of the head length in the juveniles, 53.6 percent in the half-grown specimens, and 52.2 percent in the adults. The head is normally widest just back of the eyes. In juvenile specimens there is a definite distinction between the head and neck, a condition not so noticeable in adults.

TABLE III

THE RELATIONSHIP OF THE NUMBER OF COSTAL GROOVES BETWEEN ADPRESSED TOES AND THE SNOUT-VENT LENGTH OF *Plethodon richmondi*

All measurements are in millimeters

Number of grooves	N	Mean	$\pm \sigma$	Range
11	2	54.5	....	52.5–56.5
10	12	47.9	±4.22	42.0–59.0
9	15	38.8	±2.82	34.5–43.5
8	8	32.5	±1.77	30.5–36.0
7	12	31.1	±1.57	28.5–33.5
6	2	25.0	....	21.5–28.5
5	6	19.8	±1.04	18.0–20.5
4	12	17.8	±.89	16.0–19.5
3	3	17.2	....	16.5–17.5
2	1	16.0	....	....

These data on the relative growth of *Plethodon richmondi* show that (1) the tail grows in length proportionately faster than does the body; (2) the limbs grow proportionately slower than does the body; (3) the head grows in length relatively slower than does the body, and the head grows in width proportionately slower than it does in length; (4) the number of costal grooves between the adpressed toes is dependent upon the size of the individual.

LOCALITY RECORDS.—*Plethodon richmondi* has been collected at the following localities in southwestern Ohio. (Most of the specimens are deposited in the collections of the Museum of Zoology at the University of Michigan, while a few collected at the beginning of this study are in the collections of the Dayton Public Library Museum in Dayton, Ohio.) *Brown Co.:* 5 miles east of Ripley (13); *Champaign Co.:* Kiser Lake (11); *Clark Co.:* 1 mile West of Springfield (1); *Greene Co.:* Glen Helen at Yellow Springs (91), Clifton Gorge (1), 2 miles south of Zimmerman (1), 1½ miles south of Alpha (19); *Miami Co.:* Ludlow Falls (2), Owen Farm on Wildcat Road (14); *Montgomery Co.:* 5 miles northeast of Dayton (6), Sunderland Falls (23); Taylorsville Dam (2); *Warren Co.:* Fort Ancient, 8 mi. East of Lebanon (5).

REMARKS.—Specimens with snout-vent lengths between 21.5 mm. and 28.5 mm. are conspicuously absent from my observations. The specimens ranging in size from 16.0 to 21.5 mm. snout-vent length were collected in the spring. Those with snout-vent lengths between 28.5 and 32.5 mm. were collected in September and October. Growth between 21.5

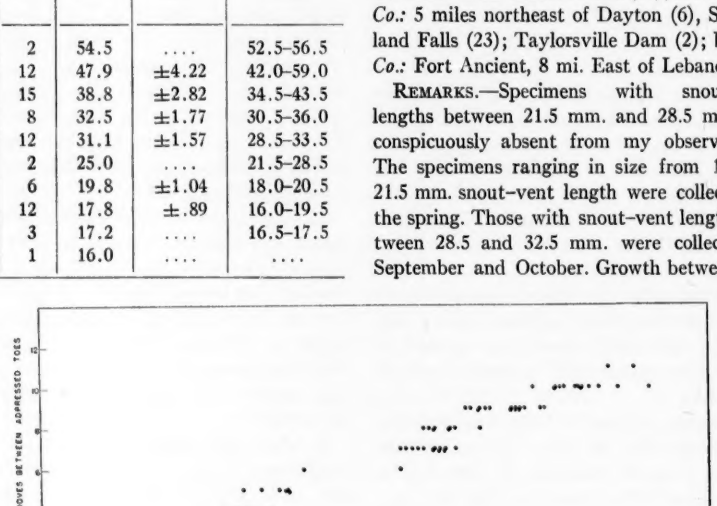

Fig. 1. The relationship of the number of costal grooves between adpressed toes and the snout-vent length of 73 specimens of *Plethodon richmondi*. (The snout-vent length is in millimeters and is plotted on the logarithmic scale.)

mm. and 28.5 mm. must take place in the summer when these salamanders are so difficult to find.

ACKNOWLEDGEMENTS.—I wish to take this opportunity to thank those people who have assisted with this work. For their aid in the field I am indebted to Richard S. Brown, Doyt E. Ladd, Richard R. Knotts, and Harold J. Walter. John T. Wood of the Virginia Fisheries Laboratory has supplied information concerning specimens in his collection. Dr. George W. Byers of the University of Michigan has been especially helpful in identifying some of the insect material found in the stomachs of the salamanders. Dr. Charles F. Walker has read the manuscript and has offered many suggestions.

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MUSEUM OF ZOOLOGY, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN.

A New Subspecies of the Snake *Masticophis lateralis* from California

WILLIAM J. RIEMER

IN the region surrounding San Francisco Bay a number of species of terrestrial vertebrates tend to be more richly supplied with red, orange, or yellow pigments than related forms in adjacent areas. Examples are the salamander *Ensatina eschscholtzi xanthoptica* (Stebbins, 1949), the snakes *Thamnophis elegans atratus* (Fox, 1951), *Lampropeltis zonata* (=*multicincta*) *multifaciata* (Klauber, 1943), and the bird *Melospiza melodia pusillula* (Marshall, 1948). One might also mention the mice *Reithrodontomys r. raviventris* and *Reithrodontomys raviventris halicoetes* which according to Hooper (1944) probably evolved in the immediate vicinity of the Bay and therefore may have been influenced in some way by it. No satisfactory explanation for this striking phenomenon is yet available.

An additional instance of extreme development of orange pigment is furnished by a new subspecies of striped racer.

Masticophis lateralis euryxanthus,
subsp. nov.

Fig. 1

HOLOTYPE.—Adult female, No. 50391, Museum of Vertebrate Zoology (MVZ), collected by Archie Mossman, August 15, 1950, in the Berkeley Hills, Berkeley, Alameda County, California. Original number: 893, W. J. Riemer.

DESCRIPTION OF TYPE (ANIMAL ANESTHETIZED).—Length from snout to vent, 84 cm.; from vent to tip of tail, 36 cm.

The type agrees in all particulars of scutellation with the detailed description given for the species by Van Denburgh (1922). It also agrees with the much briefer description given by Hallowell (1853) for the type of *Leptophis lateralis*, except that the upper portions of the preorbitals form part of the dorsal surface of the head rather than part of the lateral surface. This discrepancy presumably is the result of an error in the original description. There are 198 ventrals and 122 pairs of caudals.

The dark dorsal color of the body is divided by a pair of light stripes into three portions, a broad vertebral region and two narrower lateral regions. The color of the vertebral portion is sooty black fading on the tail and the top of the head. The lateral portions are less intensely black and are not present beyond the vent or forward of the neck. The dorsal color extends ventrally to include the ends of the ventrals from the vent forward to a point about

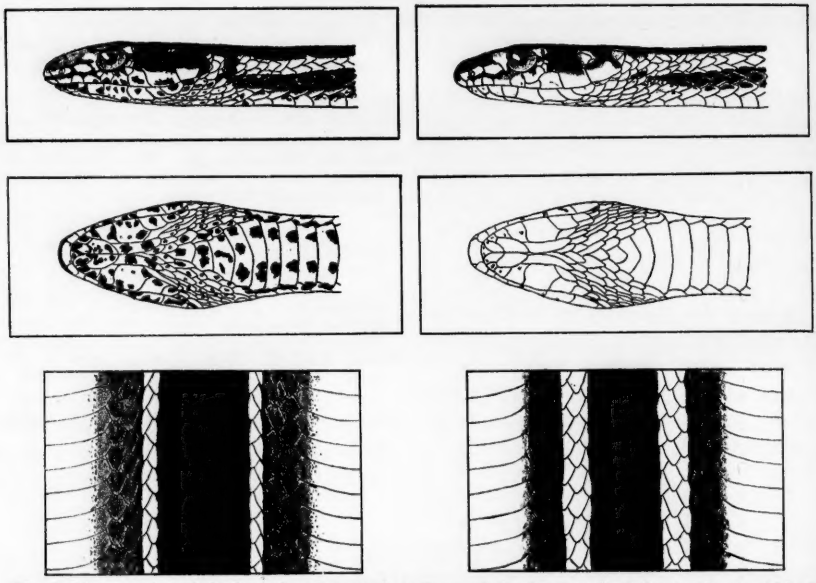

Fig. 1. Pigmentation of the lateral and ventral surfaces of the head and of the trunk at mid-body. Left: *M. l. lateralis* (MVZ 21362) from San Benito County. Right: *M. l. euryxanthus* (MVZ 50391, holotype) from Alameda County, California.

one-fifth the length of the body back from the snout. Here the dorsal color leaves the ventrals and gradually ascends the first and second scale rows. The two longitudinal light stripes are yellow-orange. Close examination reveals them at midbody to be basically a cream color, 9 F 1 (Maerz and Paul, 1930), with an overlying, unevenly distributed suffusion of orange, 10 D 10. Viewed from a distance just sufficient to obscure the irregularities of the stripe color the overall hue is saffron, 10 J 8. The stripe color is similar from the neck to the posterior third of the body where the intense orange fades out. Ventrally the body is orange on the throat, 11 K 11; pinkish-yellow at midbody, 10 F 6; and bright pink at the vent, 2 J 2. The entire underside of the tail is also pink and becomes slightly darker posteriorly, 3 J 3. The ventral colors grade gradually into one another. The underside of the head and the supralabials are white or light cream with a heavy scattering of orange pigment. A pair of small indistinct black spots is present on the mental and one spot is present on each of the first four infralabials on each side. The iris is golden-orange dorsally, 10 L 8. On the anterior two-thirds of the body the lateral orange stripe includes about two-thirds of the third scale row, all of the fourth scale row and about one-third of the fifth row. The ventral edge of the scales of the third row is occupied with a black border to the light stripe. The stripe on the posterior third of the body occupies all of the third scale row and from three-fourths to all of the fourth row. Margins of the stripe here are less distinct than anteriorly. At the hind portion of the head the lateral light stripe broadly joins the ventral light area. An uninterrupted light line connects the nostril and eye. The dark ventral border of this stripe is not present across the rostral.

Only six specimens of this subspecies are known to the author. Three of these (MVZ 33885, 50390, 50391) are from the vicinity of Berkeley, Alameda County and the others from near Somersville (MVZ 40484), near Alamo (MVZ 58215), and from Mt. Diablo (MVZ 4866), Contra Costa County. Possible intergrades have been examined; these were not seen alive and hence the color characters are unknown. That the species is rare in the area east of San Francisco Bay is indicated by the very small number of specimens in collections from this area. (Fig. 2.)

COMPARISON OF SUBSPECIES.—The subspecies *M. l. euryxanthus* may be distinguished from *M. l. lateralis* by:

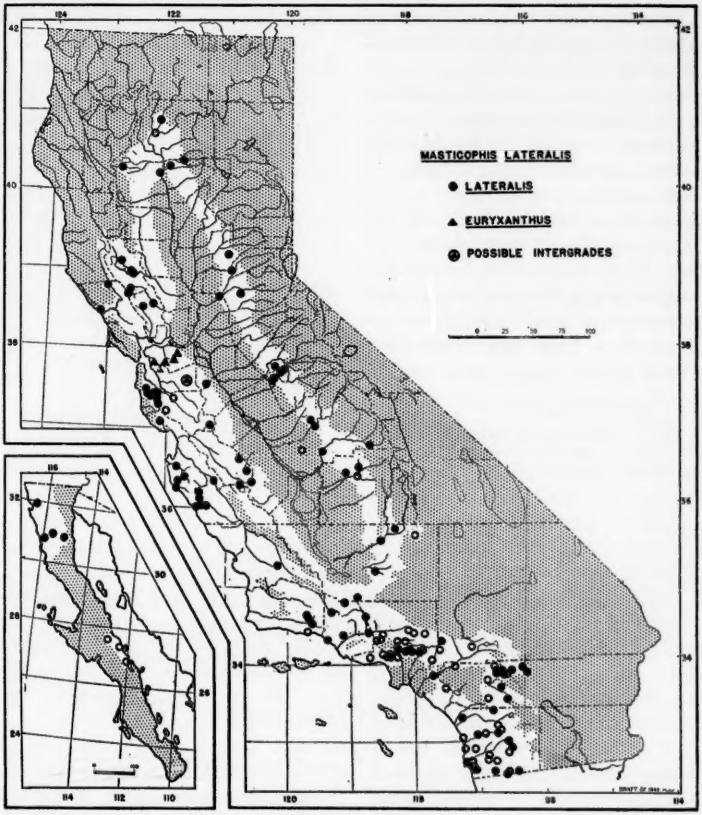

Fig. 2. Locality records for *Masticophis lateralis lateralis* and *M. l. euryxanthus*.

Solid symbols represent specimens examined; hollow symbols, those not examined. Unshaded area indicates probable total range of the species.

1. A broad dorsolateral light stripe, one and two half scales wide, or, occasionally, two full scales wide on the anterior two-thirds of the body. Occasionally individuals from other parts of the range have a stripe wider than the two half scales usual for *M. l. lateralis* but the margins are not distinct or the stripe is irregular.

2. A virtual lack of black spotting on the ventral surface of the head and neck. Juveniles may show very sparse and weak black spots. An occasional specimen from other parts of the range may lack spots in one of the two places. Spotting is heaviest in individuals from southern California and in melanistic ones. Chin spots tend to form a symmetrical pattern in animals from Tehama County.

3 A. light stripe between nostril and eye usually not interrupted by dark vertical lines along the margins of the loreal.

4. The lack, usually, of a dark line across the rostral, representing a connection between the supralabial stripes.

5. The direct communication anteriorly between the lateral light stripe and the light venter. This character appears to be uniformly present in specimens from the counties touching on San Francisco Bay, but is irregularly present elsewhere except in southern California where such communication is absent or very rare.

6. The absence of dorsal color on the ventrals for a distance back from the snout equal to four and one half to six times the distance from the snout to the posterior edge of the parietals. In *M. l. lateralis* the dorsal color is retained on the ventrals from one and one-half to four times

(usually two to two and one-half times) the snout–parietal distance back from the snout. Rarely it may be even farther back.

7. A sooty black dorsal color. Melanistic individuals are, however, not uncommon throughout the range of the species. Usually the dorsal color is olive, olive brown, blackish-olive or dark brown.

8. The presence in life of a heavy suffusion of orange-rufous on the anterior light portions of the body. In *M. l. lateralis* the stripes are light cream or pale yellow and the anterior ventral surfaces are pale yellow or pale orange. A juvenile of *M. l. euryxanthus* has a white chin area as is typical of young *M. l. lateralis*.

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MUSEUM OF VERTEBRATE ZOOLOGY, UNIVERSITY OF CALIFORNIA, BERKELEY 4, CALIFORNIA.

Definition of Some Little-Understood Members of the Leptodactylid Genus *Syrrhophus*, with a Description of a New Species

I. LESTER FIRSCHEIN

THE genus *Syrrhophus* as currently recognized in literature is wide-spread, ranging from southern Texas to South America, and is distinguished from related genera almost entirely on the basis of a single character: i.e., the absence of vomerine teeth. Although the validity of single character definition of genera is not in question at this point, the loss of vomerine teeth in the genus *Syrrhophus* seems merely to reflect a common tendency among many of the various eleutherodactyloid genera. Separation of *Syrrhophus* from related genera solely on the basis of this character certainly has little support. At least one *Eleutherodactylus* (*E. mexicanus*) shows a proclivity for the loss of the vomerine teeth and one *Syrrhophus* (*S. latodactylus*) may retain, to some degree, these teeth. In the genus *Microbatrachylus* we find the Mexican species generally are without vomerine teeth whereas all the Costa Rican forms have these teeth present (Taylor, 1952: 663). Taylor, fully aware of the inconstancy of vomerine teeth as a generic criterion, stated (1941: 89) that the presence of teeth in *M. lineatissimus* (a Mexican species) and in species of *Syrrhophus* should not invalidate the allocation of any form to its indicated genus if the species agrees essentially with the conception of the genus as a whole.

A combination of characters does exist however, which delimits a natural group of lesser scope than the heretofore recognized "*Syrrhophus*," and to which the generic name properly belongs. The Mexican and the United States forms of this genus are something quite apart from those referred to it from Central and South America. Noble (1922: 18) suggested that the genus *Syrrhophus* as now recognized may not be of monophyletic origin but is instead, polyphyletic. Actually the artificial assemblage of *Syrrhophus* (*auct.*) represents the condition in phylogenetic schematics known as isochronous homeomorphy (Haas and Simpson, 1946). Parallelism in the most outstanding character, i.e., absence of vomerine teeth, resulted in such resemblance that the

group appeared to be, superficially, entirely natural.

Dunn (*in litt.*) pointed out that the past arrangement of the genus was, at least in part, based on mis-identification. Especially is this true for the Central American forms allocated to *Syrrhophus*. According to the information forwarded by Dunn it can be shown that some of the species from Central America assigned to *Syrrhophus* actually possess vomerine teeth and never should have been placed in the genus. There is no real evidence available that there is an eleutherodactyloid species (i.e. *Syrrhophus*) without vomerine teeth in Nicaragua, Costa Rica or Panamá.[1] In Colombia and Ecuador there are many eleutherodactyloid frogs lacking vomerine teeth in juvenile and adult alike. Parker (1932: 344) believed that these forms stemmed from varied stocks of South American *Eleutherodactylus*. He suggested that the South American *Syrrhophus* with large terminal digital disks developed from different stock than the species bearing smaller disks. His suggestion, that the southern continent's *Syrrhophus* may represent several natural groupings rather than one, merits careful consideration even though the extremes mentioned for the digital expansion may well appear independently in any one natural group of eleutherodactyloids. The Mexican species of *Syrrhophus* on the other hand are necessarily to be considered as monophyletic and distinct. The *sensu latus* status of *Syrrhophus* should not be maintained even as a matter of convenience; in order to express correct relationships, the Central and South American species formerly assigned to the genus must be deleted.

The range of diagnostic characters in Mexican *Syrrhophus* is so extensive and all-inclusive, involving webbing, width of digital tips, external and internal vocal sacs, development of tympanum, distinctness of parotoid glands and axillary glands, etc., that one may even suspect the Mexican group (i.e. *Syrrhophus, sensu strictu*) of being polyphyletic. Some constancy of certain combinations of characters exists, however, reducing the possibility of development of this group from more than one stock of eleutherodactyloids. There is a somewhat homogeneous group present among the Mexican *Eleutherodactylus* that has several characters which may be considered basic in the composition of a "primitive" *Syrrhophus* (*E. occidentalis, E. calcitrans, E. mexicanus*, and perhaps *E. saltator*). The tarsal fold is absent, the digital tips are small or slightly enlarged, the vomerine teeth have a tendency to be reduced or absent, and the basic palmar and plantar tubercles are like those of *Syrrhophus*. This assemblage may have had a common origin with the stem group of *Syrrhophus*. Probably *Syrrhophus* split off from a group unknown today and, like the aforementioned assemblage of *Eleutherodactylus*, retained in part some features of this group. *Syrrhophus* perhaps arose a little earlier from the ancestral stock because many of the more primitive eleutherodactyloid features are represented in modern *Syrrhophus*. If this view is correct, the genus *Syrrhophus* developed along slightly different lines in some respects than other Mexican groups, and the peculiarities developed, although slight, may be considered quite characteristic of the entire genus. There is a peculiar pattern of palmar and plantar supernumerary tubercles, a tendency to retain only a vestigial interdigital web and a development, in at least one form, of a frontal fontanelle. The genus also possesses a characteristic body build, the head generally appearing wider than the body and the general proportions of the body not as stout as in many of the species of *Eleutherodactylus*. *Syrrhophus* has its own characteristic color pattern, the dorsal surface being nebulous or vermiculate; this condition is unparalleled in Mexican *Eleutherodactylus*. The evidence points out the fact that the genus *Syrrhophus* (*sensu strictu*) is a group quite distinct from other eleutherodactyloid genera.

There seems to be a constant measurement of a morphological nature available for consideration in comparing the various eleutherodactyloid groups of Mexico. *Syrrhophus* and *Tomodactylus* have a tarsus which (when measured from the exterior tibio-tarsal fold to base of the inner metatarsal tubercle) is less than two times the length of the foot. In

[1] After this manuscript was submitted to press, Taylor (Univ. Kansas Sci. Bull; 1952, 35 (1): 577–942) allocated all of the Costa Rican species formerly placed in the genus *Syrrhophus* to the genus *Eleutherodactylus* where they rightfully belong (*lutosus, hylaeformis, riveni, caryophyllaceus, pardalis*). However, Taylor characterizes several species as not bearing vomerine teeth (*lutosus, diastema, pardalis*). Dunn (*in litt.*) relates that specimens of *E. lutosus* examined by him have vomerine teeth and that the type of *S. ineptus* Barbour, now synonymized with *E. diastema*, bears vomerine teeth. *S. pardalis* Barbour, described without the mention of vomerine teeth, has such teeth present according to Dunn.

Microbatrachylus and *Eleutherodactylus* the tarsus is small, contained in foot length over two times. Of these four genera *Tomodactylus* is the most uncertain in position. The use of the presence of the conspicuous lumbar-inguinal glands as a criterion for identification of *Tomodactylus* is of some diagnostic value but I question its employment as an index character at the generic level. *Tomodactylus* is difficult to differentiate unless many "fine point" characters are employed. For the moment it is only necessary to point out that *Tomodactylus*, like *Syrrhophus*, is restricted in range. It occurs in the southern peripheral Mexican plateau areas (occidental and oriental). This genus does not split into discrete groups as is true of *Syrrhophus*.

The genus *Syrrhophus*, as known in México, adjacent areas of Guatemala, and the United States, is clearly divisible into two major assemblages. One is a complex of the Sierra Occidental (two palmar tubercles), the other a complex with sub-groups inhabiting the central plateau, Sierra Oriental escarpment and the Atlantic coastal lowlands (three palmar tubercles). These assemblages are presumably allopatric and represent a peripheral distribution from some common stock formerly inhabiting the central Mexican plateau.

Genus *Syrrhophus* Cope

Syrrhophus Cope, Amer. Nat., vol. 12, no. 4, 1878, p. 253. Genotype, *Syrrhophus marnockii* Cope, *idem*, p. 253 (near San Antonio, Texas).

Malachylodes Cope, Proc. Amer. Philos. Soc. vol. 18, no. 104, 1879, p. 264. Genotype *Malachylodes guttilatus* Cope, *idem*. p. 264 (Guanajuato, Mexico).

Syrrhopus Boulenger, Proc. Zool. Soc. London. pt. 2, 1888, p. 206. (Emendation of *Syrrhophus* Cope.)

Syrrhaphus Günther, Biologia Centrali-Americana, Reptilia and Batrachia, 1900, p. 215. (Emendation of *Syrrhophus* Cope.)

DIAGNOSIS.—A combination of characters delimiting the genus from the closely related *Tomodactylus*, *Microbatrachylus* and *Eleutherodactylus* include: vomerine teeth usuallly absent; flat glandular area behind tympanum; ventral disk present, limited posteriorly by a transverse fold not reaching femora; small flat inguinal gland; vocal sac usually present in males; testes and ovaries unpigmented; rounded canthal region with no discernible ridge; fingers and toes lacking a distinct web; palmar supernumerary tubercles numerous; median palmar tubercle flattened and widened.

The species of *Syrrhophus* are imperfectly known in all parts of their expected ranges and their distribution is apparently very spotty. Some species are known from only type localities and from but few specimens; a few others are known to be fairly wide-ranging forms. The paucity of material in the various museums may be laid to the secretiveness of the animals in the field. For the most part *Syrrhophus* is extremely elusive in spite of abundance. One group of collectors, of which I was a member, spent many man-hours tracing a single voice in an area where, to judge from the numerous calls heard, the form was common.

In this present paper I would like to discuss several of the lesser known members of the genus from the Sierra Oriental complex and also to describe a new species. It is pertinent, I believe, at this time to so re-define this difficult material before attempting a résumé of the genus as a whole. A phylogenetic consideration of the species members of *Syrrhophus* will appear in a later paper.

In the mountains near San Luis Potosí the University of Illinois Mexican Expedition for the summer of 1949 obtained a single specimen of *Syrrhophus* which should be considered novel. Of the three known species of *Syrrhophus* that occur or have been reported in the state of San Luis Potosí (*S. latodactylus*, *S. campi*, *S. guttilatus*), only *guttilatus* may be confused with the new form and it is the only species of the group known from the same locality (see remarks below under *S. guttilatus*).

Syrrhophus petrophilus, sp. nov.

TYPE.—University of Illinois Museum of Natural History, No. 7807, collected in the mountains (Sierra San Miguelito) 3 miles southwest of San Luis Potosí, San Luis Potosí, July 18, 1949, by D. Langebartel.

DIAGNOSIS.—*Syrrhophus petrophilus* is a member of the eastern and central Mexican plateau complex of the genus *Syrrhophus* with three palmar tubercles, and belongs to the group of the genus with digits not or but very slightly widened at the tips (*S. smithi*, *S. leprus*, *S. guttilatus*). It is most closely related to *Syrrhophus smithi* Taylor from Galeana, Nuevo Leon, differing by having a larger tympanum, a

shorter arm and longer leg, and an eye that is wider than its distance from the nostril.

DESCRIPTION OF TYPE.—Head noticeably wider than body, its width (10.7 mm.) approximately equal to its length (10.5 mm.); eye large, its diameter much greater than its distance from nostril; width of upper eyelid a little more than half interorbital distance. Tympanum large, distinct, subcircular, slightly higher than long; diameter of tympanum about two-thirds that of eye, situated about one-third its diameter from eye; tympanic membrane mottled; a well defined, thickened, tympanic border except for upper area; tympanum flaring outward, sloping broadly to lip; glandular tubercles fairly conspicuous at lower posterior border of tympanum and posterior to angle of jaw. Snout somewhat truncate; canthus rostralis round; loreal region rounded and gently sloping to upper lip, not oblique.

Vomerine teeth absent; maxillary teeth and pre-maxillary teeth present (hidden by fold of outer ip); premaxillary teeth slightly arched and on a lower level of jaw than maxillary teeth. Choanae widely separated, laterally situated and partially hidden by jutting maxillary bone. Mucous palatine glands in two patches, beginning anterior to choanae at tip of median palatal ridge and extending posteriorly and outwardly but medially to edge of choanae; these glands reach almost to transverse vomerine bone where patches are separated from mid-line groove by one-half width of a single patch. Tongue thick, pyriform, slender anteriorly, widening posteriorly, papillate, not notched behind, free posteriorly about one-third its length.

No interdigital webbing; heels touch but do not overlap when legs folded behind; tibio-tarsal articulation reaches posterior corner of eye, inner metatarsal tubercle reaches nostril; tarsus short, little more than one and three-fourths length of foot.

Arm stout, short, wrist not reaching to end of snout; digital pads thick, terminal disks slightly truncate but barely expanded beyond width of digit; no emargination at tip of disk but slight evidence of a curved transverse terminal groove; three palmar tubercles, outer small, conical; median oval but not expanded, larger than inner; inner palmar tubercle small, round, not as high or as prominent as subarticular tubercles. Five large supernumerary palmar tubercles; large, rounded and salient subarticular tubercles; first and second fingers subequal.

Inner metatarsal tubercle elongate, rounded, much larger than subarticular tubercles although not as high; outer tubercle small, conical, high, less than half length of inner; subarticular tubercles salient, conical very much elevated, tips of tubercles pointing forward. Eight enlarged plantar supernumerary tubercles, linear in arrangement with the three inner digits (five tubercles on line with fourth toe, two with third toe and one tubercle in line with second toe); a few flat granules on surface between and above metatarsal tubercles. Digital disks of toes round, small, not enlarged beyond width of a digit.

Skin smooth above and below, sides strongly tubercular, except near leg insertion, tuberculation extending onto posterior part of venter; flat sparse tubercles extending slightly onto dorsal and ventral surfaces; parotoid area indicated by slight swelling and pitting, above and slightly behind tympanum; upper eyelid pitted slightly; low, diffused, pitted, elongate lumbar-inguinal gland; ventral disk outline indistinct; some slight granulation of postero-ventral surface of femur; postero-dorsal surface of femur with several conspicuous, flattened tubercles.

Reddish brown dorsal background; pattern of the nebulous type with flecks of darker color clouding the lighter background. Sides conspicuously spotted with white, each lateral tubercle in the skin showing as a white spot; upper lips brownish, lightly flecked with white; faint indication of interorbital dark bar, extending onto upper eyelid; heavy cream mottling lateral to antero-ventral border of tympanum and between posterior eye and upper lip; venter immaculate, with some heavier but well diffused dark spotting under chin; loreal stripe indistinct; loreal area mottled with white which breaks up the continuous pattern of line. Limbs decidedly lighter in color than body; antebrachium and brachium sparsely or dimly barred; indefinite bars on dorsal femur surface, anterior face of femur light, posterior face speckled; dorsal face of tibia barred and light barring on ventral and posterior dorsal portion of tarsus; barring slightly encroaches upon base of fourth and fifth toe and shows faintly on distal portion of

digits; dorsal surface of tarsus and foot cream. Edge of upper lip speckled but not noticeably lighter than loreal region although dark pattern breaks up to a greater extent in this area than on lores.

Snout to vent 27.2 mm.; width of upper eyelid 2.2; diameter of eye 3.9; interorbital distance 4.2; eye to nostril 3.4; head width 10.7; head length 10.5; tympanum diameter 2.6 (length), 3.0 (width); eye to tympanum 0.7; inter-choanal distance 4.5.

The type specimen is a breeding male with a sinistral vocal slit behind the tongue insertion and close to the margin of the lower jaw. There are no conspicuous folds on the skin of the throat; rather, there are two slightly impressed and darkened areas of skin far back on the gular region immediately anterior to the sternum that seem somewhat taut from an inward pressure.

COMPARISONS.—*S. petrophilus* differs from *S. smithi* in a number of details: the width of the upper eyelid is a little more than one half the interorbital distance but not three-quarters; diameter of eye is greater than (not equal to) its distance from nostrils; tibio-tarsal articulation reaches beyond tympanum to the posterior corner of eye; a large tympanum, much greater than one-half the eye; tympanum to eye less than half its diameter, about one-third; shorter arm and longer leg; wrist does not extend beyond snout; inner metatarsal tubercle is larger; head distinctly wider than body. The background color much darker than in *smithi*.

S. petrophilus superficially resembles *Tomodactylus*, according to Dr. Taylor, because of the low and somewhat elongate lumbar gland. However, in the genus *Tomodactylus* the palmar supernumerary tubercles are not numerous, nor is the median palmar tubercle flattened and widened, nor the head as flat nor the toes expanded, as in *Syrrhophus*. In *Tomodactylus* the supernumeraries on the plantar surface run along the digital basal ridges and do not extend between the metatarsal tubercles as in *S. petrophilus*.

REMARKS.—A single specimen of this species was secured as it was calling from the rocky sides of a canyon. The area was extremely xeric but for a water course at the botton. The voice, a single "peep" repeated at various intervals is typical of the genus. During the two nights spent in this area by the party (July 18 and 20) the voices of this *Syrrhophus* were to be heard in numbers along the stream and amongst the boulders of the high bank areas.

Syrrhophus guttilatus (Cope)

Malachylodes guttilatus Cope, Proc. Amer. Philos. Soc. vol. 18, no. 104, 1879, p. 264; Dugès, (In) Mem. sobre. Admin. Guanajuato, 1895; Dugès, La Naturaleza, (2), 2, Cuad. 10–11, 1892–1896 (1896) p. 482.

Syrrhophus guttilatus, Nieden, Das Tierreich, Lief. 46, 1923, pp. 399–340; Kellogg, U. S. Nat. Mus. Bull. 160, 1932, pp. 125, 127–128; Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, pp. 49, 51.

Syrrhophus guttulatus, Boulenger, Proc. Zool. Soc. London, Pt. 2, 1888, pp. 204–6.

Syrrhaphus guttulatus, Günther, Biologia Centrali-Americana, Reptilia and Batrachia, 1900, p. 217.

Syrraphus guttulatus, Díáz de León, Imprenta de R. Romo. Aguascalientes, 1904, p. 11.

Syrrhophus guttilatus (Cope) belongs to the eastern complex of the genus with three palmar tubercles. It seems to be most closely allied to *Syrrhophus petrophilus*, *S. smithi* and *S. leprus*, the group of larger forms without any apical disk expansion.

Syrrhophus guttilatus was named from a single specimen, USNM 9888 from Guanajuato, Guanajuato. It was collected and sent to Cope by A. Dugès.

There is a serious question concerning what actually constitutes the species *guttilatus* and its supposed range. There are two specimens of this form recognized at present, in addition to the type. One, which came to light shortly after the type description was published, was collected in the Sierra San Miguelito range, south of San Luis Potosí, by Edward Palmer in 1879 and was deposited at the Museum of Comparative Zoology at Harvard (No. 1670). At the present writing no systematic allocation may be made of this specimen since I am informed (letter, A. Loveridge, January, 1950), that it is no longer available and cannot be found in any institution. The second specimen assigned to this species, USNM 9907, came from the same collection as the type. This specimen in the National Museum's files is labeled as *S. guttilatus* although Cope made no reference to this individual in his description of the single type. In fact, this number (9907) is not mentioned in Cope's report on the Dugès collection. United States National Museum numbers were assigned to Cope's cotypes of *Cystignathus microtis* reported in the same,

paper, as follows; "three specimens nos. 9906-9908 and 9909". Seemingly Cope did not consider this specimen as assignable to any species at that time, and perhaps not until some later date was it allocated to *S. guttilatus*. One would suspect that Cope is not actually responsible for such a designation since this example differed radically from the type of *guttilatus* and the newly proposed genus *Malachylodes* based on the *guttilatus* type. These two specimens are supposedly from the same general locality (only 80 miles south of the locality for *S. petrophilus*). It should be noted however, that Cope's localities are evidently questioned by Dugès himself (Günther, 1900: 245), and so there may be an error in assigning either the type or No. 9907 to the Guanajuato region.

After making direct comparison of this specimen with the type, I question the designation of USNM 9907 as a member of this species. However, the vicissitudes of long preservation have obliterated many of the diagnostic characters in the type and also the specimen in question. In fact, Kellogg in his report on the Mexican amphibians (1932: 128) inferred that the type of *Syrrhophus guttilatus* is a young *Leptodactylus melanonotus*.

When the type was re-examined it was noted that it showed quite distinctly the one diagnostic character that may differentiate this form from any other known Mexican *Syrrhophus*. This character, in Cope's view, carried the magnitude of differentiation necessary for establishing a separate genus, *Malachylodes*. When the head is held against a strong light a narrow frontal opening is discernible. This represents a very primitive condition found only in the most generalized members of the eleutherodactyloid stock ("*Borborocoetes*" group). Lutz and Lutz, (1939: 227, pl. II) reported a *Phyllomedusa* with such a "frontoparietal" fontanelle. This fontanelle, I believe, is merely a token retention of a primitive character in the *Syrrhophus* stock which may be considered "advanced" from the generalized eleutherodactyloid groups. No other specimens of *Syrrhophus* examined (including the supposed *guttilatus* from the type locality), possess this character. As the fontanelle represents only a primitive developmental stage of the complex generic groups of eleutherodactyloids, apparently appearing quite by accident in an advanced group (*Syrrhophus*), such a character should not warrant generic recognition. The species *guttilatus* fits very well within the general schematics of its closely related members of the eastern Sierra complex.

Some of the more salient (although they seem rather superficial in degree) characterizations of *guttilatus* that I have been able to glean from an examination of the type are as follows:

Canthus rostralis rounded; flattened lores; tympanic diameter slightly less than one-half eye (1.2 mm.); no marked tuberculation of lateral areas of the body; posterior portion of the venter areolated; tubercles flattened on the palmar surface, three metacarpal tubercles (outer present but very small, much less than one-third of median); median tubercle expanded, more or less oval in shape; no well developed supernumerary tubercles present; tarsus less than one and a half times the length of foot; inner metatarsal tubercle small, hardly elevated, about size of subarticular tubercles; outer metatarsal tubercle almost same size as inner; many small supernumerary tubercles, insignificant in size, follow metatarsal plantar ridge at base of each toe (most likely ridges due to extreme desiccation); heavy postero-ventral femur areolation; flattened tubercles present, extending to dorsoposterior surface of femur. Snout to vent 21.7 mm.

Other than Cope (the type describer), only Kellogg has made adequate descriptive notes and these some twenty years before I examined the type. In addition he included the following characterizations which I have excerpted: areolate skin only on hinder half of abdomen, skin of upperparts and sides apparently smooth, areolated only when viewed with a lens; some areolation on lower half of sides; skin of underparts smooth anteriorly; inferior surface of thighs coarsely granulated; loreal region subvertical; head flat above; maximum width of upper eyelid one-half to two-thirds the width of interorbital region; external nares small, widely separated; distance of nares from eye less than diameter of eye; tongue subpyriform; fingers free, without vestige of web membrane at base; first finger shorter than second; large subarticular tubercles continued backward on metacarpals; apical disks slightly wider than finger, truncated; toes with slight vestige of web at base; free portion of fourth toe twice as

long as free portion of fifth; subarticular tubercles large at ends of metapodial bones; plantar surface of foot covered with numerous minute tubercles; inner metatarsal tubercle larger than outer; apical disks of toes smaller than those of fingers; tibio-tarsal articulation reaches posterior edge or to middle of eye, heels overlap; color (in alcohol): upperparts ranging from dark to brownish drab, marked with numerous blue-black spots without sharply defined borders, these tending to merge with ground color; a blue-black mark curving from above, downward behind tympanum; fore and hind limbs with dark cross bands; external digit of hand and foot with faint cross bands; upper and posterior surfaces of femur with white or light-colored spots on a darker ground color; edge of upper lip with a few light splotches; darker streak along canthal region from external narial opening to eye; ground color much lighter on sides, with distinct light spots; inferior surfaces light colored, unspotted.

USNM 9907, originally assigned to this species, may be differentiated from it by a number of characters, but due to the stage of preservation and its small size (14.4 mm.) this specimen is difficult to assign to any *Syrrhophus* species. Some of the characters discernible are as follows: no frontal opening present (head shape distorted in outline and various features of head cannot be remarked upon); tympanum very small, much less than one-third of diameter of eye; heavy lateral body areolations which may be described as flattened tubercles; well developed outer palmar tubercle more than one-half size of oval median palmar tubercle; median palmar tubercle expanded laterally; palmar supernumerary tubercles well developed, conical, not high; digital tips rounded; well developed digital pads; inner metatarsal tubercle large, outer tubercle less than one-half its length; a few well developed supernumerary tubercles on sole; glandular area somewhat elongate, but not elevated, in lumbar-inguinal region; toe disks rounded, not expanded beyond digital width.

The limits of the range of *S. guttilatus* should be restricted to the type locality. The type specimen is the only individual referable to this species known to the author. Others that have in the past been assigned to it are either questionable or unavailable for examination at the present time.

Syrrhophus smithi Taylor

Syrrhophus smithi Taylor, Proc. U. S. Nat. Mus. vol. 89, 1940, pp. 43–45; Taylor and Smith, Proc. U. S. Nat. Mus. vol. 95, 1945, p. 582; Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, pp. 49, 51; Maldonado-Koerdell, Rev. Soc. Mex. Hist. Nat. vol. 10, 1949, p. 250.

Syrrhophus smithi is a representative of the eastern complex of the genus belonging to the group in which the digits are not or but slightly widened at the tips (*S. petrophilus, S. leprus, S. guttilatus*). This species may be confused with the small *S. campi* occuring commonly in the same state. Comparison of the paratype of *smithi* (Edward H. Taylor Collection, No. 23067 from the type locality, 15 miles west of Galeana, Nuevo Leon) with examples of *S. campi* reveals many differences.

The paratype of *S. smithi* is a young individual measuring 15.1 mm. from snout to vent whereas the type measures some 33 mm. Because of its juvenile condition many diagnostic characters of *smithi* cannot be confirmed by examination of this specimen.

In *S. smithi* the toes are short, robust and thickened, tapering to the end with no conspicuous digital swelling as compared to the narrowest width of the digit itself. In *campi* the digital tips are definitely widened (one and one-third to about two times the narrowest digital width) and the fingers are slenderer and longer. There is a terminal groove at the tip of the digital pads in *campi* that is lacking in *smithi*. The outer two fingers of *campi* match in size whereas the fifth digit in *smithi* is much smaller than the fourth. The dorsum in the young paratype of *smithi* is much smoother than in *campi* and the venter is light in color and smooth, with an indication of stippling on either side of a mid-line clear area. There is more stippling on the chin and venter of *smithi* than found in any example of *campi* examined. The upper arm in *smithi* is smooth with no indication of any tuberosity such as found in *campi*. The underside of the thigh is not as distinctly granular as *campi* and the tubercles on the lateral areas of the body are not as prominent.

Like the new form described from San Luis Potosí (from a region not very far removed from the type locality of *smithi*), *S. smithi* may be separated from other members of its group within the eastern complex by the absence of

any web between the toes. It may be further differentiated by the following characters as originally described in the diagnosis and the type description by Taylor. The diameter of the eye equals its distance from anterior edge of nostril, separated from tympanum by more than half diameter of tympanum; tympanum subcircular, more than half eye diameter; width of an eyelid four-fifths interorbital width; when legs folded at right angles to the long axis of body heels touch but do not overlap; head a little narrower than body; arms long, wrist extends beyond snout when brought forward parallel to body, tibio-tarsal articulation to tympanum; parotoid gland apparently absent; lumbar gland about 6.2 mm. long and one-third as wide (the condition of this gland is much like that described for *S. petrophilus* and appears in shape like the glandular areas found in the genus *Tomodactylus*). Choanal opening somewhat enlarged, nearly lateral, but not concealed by jaw when viewed from below; flattened tubercles on eyelid; underside of femur with longitudinal grooves; vocal sacs in male unknown.

Taylor noted that *S. smithi* is related to *S. guttilatus* but differs in having shorter legs and longer arms and a totally different color (vinaceous-drab to brownish above with sharply defined blue-black spots and femur barred with rufous in *guttilatus*, whereas *smithi* is generally ash gray, with dark flecks above, white below). Taylor's color notes on *smithi* are as follows: "numerous indefinite darker gray, blackish or brownish flecks on dorsal surface; large blackish-brown spot on the gland with some minute light flecks; limbs lighter than body, with indefinite brownish bars on femur, more pronounced bars on tibia; feet dimly barred; a triangular light spot between orbits; tympanum brownish; a dark loreal stripe; edge of lip much lighter than lores; entire ventral surface white with a sparse darker peppering".

The paratype of *S. smithi* agrees essentially in most respects with the generalized color pattern described herein but, as Taylor noted, there are minor variations in pattern disposition between the paratype and the type. Unfortunately, Dr. Cochran informs me that the type cannot be located in the collection at the U. S. National Museum (No. 108594). These are the only known examples of *Syrrhophus* that have ever been assigned to this species. It is not known from any locality other than that recorded for the type.

Syrrhophus verrucipes Cope

Syrrhophus verrucipes Cope, Proc. Amer. Philos. Soc. vol. 22, no. 120, 1885, p. 383; Kellogg. U. S. Nat. Mus. Bull. 160, 1932, pp. 126–7, 128–129; Smith, Journ. Wash. Acad. Sci. vol. 37, no. 11, 1947, p. 408; Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, pp. 50, 52–3.

Syrrhaphus verrucipes, Günther, Biologia Centrali-Americana, Reptiles and Batrachia, 1900, pp. 216–7.

Syrrhaphus verrucipes, Diáz de León, Imprenta de R. Romo. Aguascalientes, 1904, p. 10.

This species at present is known from but a single type specimen. It formed part of a small collection made by Cope and Dr. Santiago Bernad. In the type description Cope gave himself credit for obtaining the specimen. However the type entry at the Academy of Natural Sciences, Philadelphia, shows evidence that this specimen was actually collected by Dr. Bernad, and probably then forwarded to Cope according to Dr. Henry Fowler in whose hands fell the task of making this specific entry. The specimen upon which Cope based his description came from the bottom of a rocky gorge (barranca) of a stream near its junction with the San Miguel River, at least 1800–2000 feet below the general level of the town of Zacualtipán in northeastern Hidalgo, México. According to Cope, "the entire region is elevated and belongs to the warmer part of the Tierra Fria, but the ravines which intersect the country in many places have the characteristics of the lower Tierra Templada, and at a very short distance from the town of Zacualtipan the region merges into the Tierra Caliente."

The type specimen of *S. verrucipes* was reported as lost by Kellogg. No specimens referable to this species were found in any American institution. However Kellogg suspected that the type might actually be located in the collection at the Academy of Natural Sciences of Philadelphia along with other types and cotypes designated by Cope. I was fortunate in the summer of 1949 and again in 1950 to visit the Academy in Philadelphia and through arrangements with Dr. E. R. Dunn, was permitted to peruse the collection. Among the many Cope types in this collection I came upon that of *S. verrucipes* bearing the correct locality designation. This specimen is now numbered ANSP 11325. It is most relevant at this time

to recast a description of this species since no other remarks on the characteristics of this particular form now exist other than the type description by Cope.

In spite of long preservation the color pattern of this example still resembles that of a typical *Syrrhophus*: dark brown with distinct small black spots scattered over the dorsal surface, very sparse in number; dorsal area of snout darkish; head crossed by a light bar touching anterior edge of eye, followed posteriorly by a dark interorbital band; antebrachium conspicuously banded with dark rings; tibia and tarsus banded with black. (Cope described the coloration as dark bluish-gray above, marked with numerous black spots with ill-defined borders; limbs similar, with black cross bands, which are continued on external digit of each foot; closely spaced white spots on dark ground color present on upper surface of femur; a few small white spots on dark posterior face of femur; edge of lips with a few light spots; underparts white, unspotted.) When venter viewed under magnification (4×) the surface was seen to be finely spotted with black against a brown background. The sides areolate; skin of dorsum smooth with no hint of any sort of rugosity; posterio-ventral portion of femur rugose; snout acuminate, nostril lateral and near forward edge of snout; canthus rostralis round; head slightly wider than body; terminal disks of fingers enlarged, especially on outer two digits, lateral groove at tip of pad present; median palmar tubercle very large, outer palmar tubercle small; thenar tubercle long and salient; subarticular tubercles strong; small supernumerary tubercles on palmar area between larger tubercles, most evident at basal area of digits, especially between first and second fingers; third finger longer than fourth; second finger longer than first; tibio-tarsal articulation reaches anterior portion of eye; tympanum very large, equal to diameter of eye, not set close to posterior corner of eye; large tubercle lateral to and slightly behind tympanum; behind this tubercle a glandular area about in region of parotoid; a low flat lumbar gland, indicated by small pustules visible under magnification; outer and inner tarsal tubercles equal in size, a few small tubercles between them; many supernumerary tubercles on plantar surface; subarticular tubercles on fingers and toes large, prominent; large internal choanae.

Cope's type description contains the following additional information and differs from the above description in some respects: tympanum little more than two-thirds diameter of eye; canthus rostralis obtuse or blunt; loreal region vertical; head flat above, moderately wide, muzzle slightly prominent; no abdominal or gular fold; apical disks of fingers a little larger than those of toes.

Smith and Taylor questioned the absence of the abdominal disk in this species since it is one of the finer characteristics of the entire generic group. Fortunately, considering the state of preservation at this time, the outline of the gular portion of the disk is still evident but the posterior abdominal fold is obliterated.

An interesting feature of this specimen is the presence of a ventral glandular area near the arm insertion and immediately above the gular fold of the disk. Taylor first mentioned to me the fact that this glandular area does exist in the genus *Syrrhophus* but it has never been heretofore described in literature. In the type of *S. verrucipes* the glandular area is small, rounded, with a dark outer ring followed by an inner light ring with a dark center. The gland is well defined on the right side, much diffused on the left.

The type is a male and has both sinistral and dextral vocal sac openings flanking the posterior margin of the tongue.

Smith and Taylor (*op. cit.*) record *S. verruculatus* from Hidalgo. The series upon which this allocation was based (EHT nos. 18681–18688) was collected near Tianguistengo, only 10 kms. from the type locality of Cope's *S. verrucipes*. I have examined part of this series (EHT 18681, 18684, 18687) and am of the opinion that these possibly may be referable to *S. verrucipes*. If I resort to the characters utilized by both Kellogg and Smith and Taylor in distinguishing the various species of *Syrrhophus* then these examples would be considered to differ enough for *S. verrucipes* as to justify a new name. However these differences I believe, are merely the result of observable degree, as they differ from author to author. In these three specimens the dorsal skin is tubercular and there is some areolation present on the venter. In *verrucipes* this does not obtain. The solar tubercles are not particularly as small in these specimens as in the type of *verrucipes*. The coloration varies dorsally from light to darkish among the three examples.

The single character of these specimens that warrants placement in the species *verrucipes* is the presence of enlarged and laterally placed inner choanae as in the type of *verrucipes*. When viewed from below, the choanae are almost entirely hidden by the margin of the upper jaw.

S. verrucipes then has eight assignable examples other than the type and is the only *Syrrhophus* member in the eastern complex with enlarged internal nares.

Form of Uncertain Position

Phyllobates verruculatus Peters

Phyllobates verruculatus Peters, Monatsber. k. Preuss. Akad. Wiss. Berlin, 1870, p. 650; Díaz de León, Imprinta de R. Romo. Aguascalientes, 1904, p. 22.

Hypodictyon verruculatus, Cope, Proc. Amer. Philos. Soc. vol. 22, no. 120, 1885, p. 383.

Syrrhophus verruculatus, Nieden, Das Teirreich, Lief. 46, pp. 399, 401; Kellogg, U. S. Nat. Mus. Bull. 160, 1932, pp. 125–6, 129; Smith and Taylor. U. S. Nat. Mus. Bull. 194, 1948, pp. 50, 52.

Phyllobates verruculatus Peters, has been erroneously assigned to the genus *Syrrhophus*. Not only is the locality unassured (although most likely this is an eastern Veracruzian form since other species of reptiles described or named from the same collection by Peters occur locally in the Veracruz region) but all other specimens allocated to this form by other authors subsequent to the type description may be shown to be in error.

The type was collected in México by Dr. Hille at "Huanusco" in Veracruz. Forwarded to Peters in Berlin it was given the number 6957 according to Dr. E. R. Dunn who examined the type during his visit to the Museum für Naturkunde in 1928. Kellogg could not find nor could I locate on any of the recent topographical maps of México the name "Huanusco" in eastern México as it appears in the type description. It is generally assumed that it is merely a mis-spelling for Huatusco in the same State.

Cope erected a new genus, *Hypodictyon*, for species of this group with an areolated abdomen. Cope (1885: 264) designated as the genotype *Phyllobates ridens* Cope, from Nicaragua, now recognized as an *Eleutherodactylus* rather than *Syrrhophus* (*auct.*). He included *verruculatus* in this genus and this led Smith and Taylor to utilize this character to designate *verruculatus* in their key. Because of faulty diagnosis, stemming originally from the type description, we now have little knowledge of the actual limits of this species. I have been able to examine all formerly assigned examples of this species except the type and a specimen in the British Museum (No. 1906.6.1.100) from Buena Vista, Guerrero, identified by Dunn as belonging to this species. This specimen is entirely out of the species complex range if we consider *verruculatus* as an eastern representative of this genus.

A specimen, USNM 123530, from San Lorenzo, Veracruz, was referred by Smith (1947: 408) to *verruculatus* on the basis of stippling on the venter. "This specimen is dark with very extensive light areas on the back. The width of the disks of the two outer fingers is one and one-half times as wide as digits; tympanum only one-half of diameter of eye; belly skin smooth, back feebly granular; choanae small." Upon examination this proved to be a well macerated and flattened example of *S. cystignathoides*. Certainly the color condition of the venter could not be made out with any clarity but it seems to be darker than in any other example of *Syrrhophus* examined.

Other specimens erroneously allocated to this species include: two at the University Michigan Museum of Zoology (Nos. 69519 from the waterfalls near Tupexic in the Necaxa region, and 69520 (F.N. 2) from 1525 M. at Necaxa, Puebla) and eight in the E. H. Taylor collection (nos. 18681–18688) assigned by Taylor to *S. verruculatus*. The Necaxa material has been examined and proved to be excellent examples of *S. cystignathoides*. I would prefer to refer the Taylor series of specimens to *S. verrucipes* by virtue of the large and laterally placed inner choanal openings. Smith and Taylor (1948: 50), because of the assignment of this series of examples to the species *verruculatus*, utilize the unique character of the large choanae (which actually, by Cope's definition, delimits *verrucipes*) to key out *verruculatus*. The original concept and meaning of *verruculatus* is now in a chaotic state of confusion. Several diagnostic features used in the description of the type may no longer be considered adequate in determining the limits of a species of *Syrrhophus* and, furthermore, it seems other ascribed characteristics of this species would tend to eliminate it from membership within that genus. Since the species *verruculatus* seems to be characterized on the basis of, in the words of the

describer, "brownish yellow, sprinkled with dark" I am inclined to believe that the type belongs to some other genus of the family Leptodactylidae. At best, if actually a *Syrrhophus*, it probably is *S. cystignathoides* which is the common species of the region around the type locality.

Dunn, the only modern worker to re-examine the type specimen, further complicated matters by noting that, besides the extremely large tympanum with a black mark over it, there were no distinct apical disks on toes or fingers. The type has no vomerine teeth; lumbar gland absent but a parotoid gland is visible.

I have not been able to re-assign any example of the genus *Syrrhophus* to this species in the light of the author's description. I am further inclined to declare this species as a *nomen dubium* (even though the type is extant) and thus delete it from any further consideration in the genus *Syrrhophus* as a valid and acceptable nomenclatorial entity. The following is a translation from the original description of this species.

"Upperside of body and limbs golden-brown spotted and stippled with black; underside brownish yellow, sprinkled with dark. Temporal region dark brown; a dark streak along canthal region and above tympanum. (Kellogg adds—a dark triangular mark with apex pointing backward occasionally present in interorbital region.) Skin of upperparts distinctly roughened with salient and prominent tubercles; throat and breast smooth; posterior part of belly areolated; behind and underside of thigh granular; tongue rounded; canthus rostralis rounded; snout a little larger than diameter of eye; lores are vertical; tympanum distinct, diameter two-thirds that of eye; first finger shorter than second, fourth a little longer than second, third finger longest; subarticular tubercles distinct; apical disks distinct, large, those of the two outer fingers larger than the small disks of the toes; large subarticular tubercles extending backward on inferior surface of metatarsals."

I wish to extend my gratitude to Dr. E. R. Dunn who kindly forwarded pertinent material relating to the genus *Syrrhophus* and to Dr. Doris Cochran, Dr. Edward H. Taylor and Dr. Norman Hartweg for making possible the loan of specimens from their respective institutions. I especially would like to thank my advisor, Dr. Hobart M. Smith, University of Illinois, for first suggesting various problems within the family Leptodactylidae and for his kindly criticism of the present paper.

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Herpetological Notes

JUVENILES OF BROOKS' KINGSNAKE, *LAMPROPELTIS GETULUS BROOKSI*.—The young of Brooks' kingsnake, *Lampropeltis getulus brooski*, have not been described. They are unusual in that a third color, red, is present in addition to the dark ground color and the light markings. The following description is taken from a living specimen 517 mm. in total length. It was collected near Homestead, Dade County, Florida, in December, 1952. The parenthesized color names and notations are from Maerz and Paul, Dictionary of Color, 2nd edition.

The dorsal ground color is black. There is a nuchal crossbar of pale yellow (10 F 2, straw), 47 similar bars on the dorsum of the body, and 13 on the tail. Some of the scales of these crossbars are light tan (12 C 3, old ivory). Eight of the black dorsal interspaces of the body, and all of the tail interspaces, bear scales centered with yellow (10 F 1), suggesting incipient crossbars. All the other dorsal interspaces of the body bear scales centered with reddish brown (5 A 10, rose biege). The sides are marked with irregular, upright yellow (10 F 1) bars, which approximately alternate with the dorsal bars but which are more numerous, 54 on the left and 63 on the right side of the body (excluding tail). Most of these lateral light bars are centered with bright red (3 D 11). Commonly, each lateral light bar bears a cluster of three, four, or five red scales. Red areas are present on the lateral light bars from head to tip of tail. The labials are dull yellow (11 E 2), each with a black border. The remainder of the head is black with numerous yellow (11 E 2) dots, especially in the temporal region. The belly is yellow (11 E 1) with dark brownish-black markings (close to 8 A 1, but darker).

In juveniles and subadults of Brooks' kingsnake, the iris of the eye is yellow with a red crescent above. In older adults the red crescent is lacking, but the iris is still conspicuously light.

The adults of Brooks' kingsnake are much lighter than the juveniles in both dorsal and ventral coloration. The original and subsequent descriptions of this subspecies emphasized the light dorsum of the adult, but omitted reference to the equally diagnostic light venter. In typical specimens the under surface is ivory, cream, or pale yellow, with spots of pinkish brown or tan.—E. ROSS ALLEN AND WILFRED T. NEILL, *Ross Allen Reptile Institute, Silver Springs, Florida.*

EVIDENCE OF VENOM IN SNAKES OF THE GENERA *ALSOPHIS* AND *RHADINAEA*.—Snakes of several genera, once thought nonvenomous, are now known to inject a toxic saliva by means of enlarged back teeth. The bite of *Hypsiglena* killed small lizards in about 45 minutes (Cowles, 1941, COPEIA (1): 4–6); that of *Leptophis* (*Thaerophis*) is reputed to kill small prey (Oliver, 1948, Bull. Amer. Mus. Nat. Hist. 92: 157–280); and that of a juvenile *Ahaetulla* produced painful symptoms in man (Neill, 1949, COPEIA (3): 228–9). Apparently *Alsophis* and *Rhadinaea* can be added to this list, although snakes of these genera are probably not so venomous as any of the others mentioned above.

In *Alsophis*, the last two maxillary teeth are conspicuously enlarged and well separated from the remainder of the series. This dentition suggests that a mild venom might be present even though the posterior teeth are not grooved. An experiment was made with a Cuban racer, *Alsophis a. angulifer*, collected at Punta Brava, Cuba, by E. Ross Allen and myself. The snake, a large adult, bit me on the lower surface of the forearm. It retained its hold, chewing until the back teeth were imbedded. After 2 minutes I forced it to relinquish its grip. Tiny cuts left by the maxillary, pterygoid, and mandibular teeth all began to swell within 4 minutes after the snake was removed. Within 10 minutes the swellings about the scratches had coalesced, and erythema was evident. Within 45 minutes a dark discoloration was noticeable about the bite, and the reddened area sent streaks for two or three inches up the arm. The bitten spot was but slightly sore. Within 4 hours a purplish-black bruise-like area almost two inches in diameter had developed about the bite. No further symptoms were noted, although the vicinity of the bite remained discolored and slightly painful to the touch for three or four days. Bites from snakes such as *Coluber*, *Elaphe*, *Natrix*, *Pituophis*, and *Lampropeltis* never produce discoloration or lasting soreness, as far as I know. Evidently *A. angulifer* is very mildly venomous.

In snakes of the genus *Rhadinaea*, the last two maxillary teeth are slightly enlarged and separated from others of the series. The genus is thought by some to be allied to *Coniophanes*, which includes mildly venomous rear-fanged snakes. It is therefore not surprising to find evidence of venom in the yellow-lipped snake, *Rhadinaea flavilata*. The species is common near Silver Springs, Marion County, Florida, and I have had many captive examples from this vicinity. The snakes fed upon cricket-frogs, *Acris gryllus dorsalis*; oak toads, *Bufo quercicus*; and young anoles, *Anolis c. carolinensis*. The method of feeding was unusual. The snake would seize a frog or lizard, chew until the back teeth were imbedded, and then remain motionless. Seldom was any prey held for less than 45 minutes. Usually

a frog would be held for about 70 or 80 minutes. A large, active frog or lizard was often retained for 2 or even 3 hours, until it had become quiescent. Apparently the yellow-lipped snake imbeds its posterior teeth and then waits until a mild venom has numbed the prey. These feeding habits were independently observed by Walter Auffenberg, of the University of Florida. Malnate (1939, Zoologica, (24): 364) observed this snake eating an *Anolis* in captivity. The snake seized the anole, held it until it ceased struggling, and then worked its jaws along the lizard's body to the head and immediately commenced swallowing operations. However, the entire process from the time the lizard was seized until it was completely swallowed took only 25 minutes.

It should be emphasized that the bite of a large *Alsophis*, at its worst, is hardly as painful as the sting of a good-sized ant; and that the diminutive *Rhadinaea* is utterly incapable of harming a human being.—Wilfred T. Neill, *Research Division, Ross Allen Reptile Institute, Silver Springs, Florida.*

A NORTHERN EXTENSION OF THE RANGE OF *PLETHODON RICHMONDI* IN OHIO.—In May of 1952 the authors collected three individuals of *Plethodon richmondi* at Elk Creek, a small stream 3 miles east south-east of Oberlin, Lorain County, Ohio. A group of twenty-four others, collected on March 15, and April 9, 1953 at Elk Creek, show the following distinguishing characteristics: range of length 72–118 mm., average length 98.1 mm.; range of intercostal grooves 20 (7 specimens) to 23 (1), average number 20.8; intercostal grooves between appressed limbs 10.3; vomerine teeth in all extend to or beyond the outer edge of the internal nares. The coloration of the Elk Creek specimens corresponds to that described and pictured by Netting and Mittleman (Ann. Carn. Mus., 27: 287–93) and Bishop (1943, Handbook of Salamanders) with the single exception that the dorsal striped phase has not been encountered.

The authors have collected thirty-six specimens of *richmondi* and have observed at least as many more. This salamander is extremely common in an area where Elk Creek cuts through a sandstone outcropping producing a small valley with plentiful talus cover. All were found beneath this cover in a habitat which was quite dry. A greater tolerance than *Plethodon c. cinereus* for dryness is possibly indicated for *Plethodon richmondi*. Only *P. richmondi* has been collected on the open, drier north-east bank, while on the well-shaded south-west bank *Plethodon c. cinereus* is frequently found in association with it.

The previous Ohio records cited by J. T. Wood (1946, Copeia, (3): 169) indicate that the range of *richmondi* extends from the Ohio River Valley, which it follows closely in southern Ohio, in an arm which presumably reaches up the Miami River Valley to include the counties of Hamilton, Green, Montgomery and Champaign in the southwestern portion of the state. To these records should be added nearby Miami County, for in the collections of *richmondi* borrowed from the University of Michigan is a series, UMMZ 107710 (14), labeled "Bethal Twnsp., 1 mile west of Phoneton, Miami, Ohio." The present collection from Elk Creek represents a range extension of 80 miles to the north-east of Kiser Lake, Champaign County, which was the former northermost collection point in the state (J. T. Wood., *loc. cit.*). Though Elk Creek is within three miles of the southern boundary of the Lake Plain, it is definitely in the Till Plain and therefore essentially in the same zone as those records cited above. According to the distribution given by Bishop (*loc. cit.*: 239), the Elk Creek collection represents the northernmost point in the range of *Plethodon richmondi*.

The authors wish to express their gratitude to Norman Hartweg of the University of Michigan Museum of Zoology for his loan of *Plethodon richmondi*.—Donald M. Green and Warren F. Walker, Jr., *Department of Zoology, Oberlin College, Oberlin, Ohio.*

UNUSUAL OCCURRENCE OF THE TIGER SALAMANDER IN NORTH-CENTRAL COLORADO.—There are occasional reports of adult tiger salamanders occurring in suitable micro-habitats which are isolated by physical barriers. A local example of this distributional phenomenon was discovered in an isolated pinyon pine grove 14 miles northwest of Fort Collins, Colorado. This foothill's woodland occupies the eastern slope of a sedimentary hogback surrounded by semi-arid grassland and is 150 miles from other pinyon forest. Near the top of the hogback there is an extensive outcropping of limestone which, at one spot, has eroded vertically to form a small cave. The cave entrance is about two feet across and opens into a chamber which extends five feet straight down and then parallel to the slope for about 25 feet, the lower end narrowing and being filled with debris.

On May 24, 1952, an adult yellow-barred tiger salamander (*Ambystoma tigrinum mavortium*) was found on moist soil under some chunks of limestone directly beneath the cave entrance. The discovery is interesting on several counts. This cave is the only such habitat in the vicinity and would seem to be quite inaccessible to a salamander. There is a sheer cliff drop on the west, and the cave is separated from flat country on the east by a dry, rocky, quarter-mile slope. There are no permanent creeks or pools in the square mile of woodland, nor are

there suitable salamander habitats elsewhere locally. Further, this species has a very low population density in its distribution throughout the northern Colorado foothills.—RICHARD G. BEIDLEMAN, *Zoology Department, Colorado Agricultural and Mechanical College, Fort Collins, Colorado.*

OBSERVATIONS ON REPRODUCTION IN THE TORTOISE *GOPHERUS AGASSIZI* IN CAPTIVITY.—Observations described here were made on captive desert tortoises, *Gopherus agassizi*. The place of their original capture is unknown.

Female No. 1 has been in captivity in metropolitan Los Angeles from 1934 until 1951 and since then in Van Nuys, California which has a summer climate somewhat warmer than that of Los Angeles. Her dimensions on September 1, 1951 were: carapace length 270 mm., height 95 mm., and maximum width 205 mm. Measurements have been made only in recent years, and growth apparently has been negligible. This tortoise has been housed continuously with from one to three adult males.

Each year tortoise No. 1 has laid eggs ranging in numbers from five to thirteen. In the ten observed instances of egg laying, it occurred between May 28 and July 21. Eggs that were permitted to remain buried out of doors either in Los Angeles or Van Nuys failed to hatch. In six of the seasons the tortoise did considerable digging one to four days (usually including one day) before the eggs were laid. Digging was done with the rear feet, one at a time. After the eggs were laid, the hole was covered over, using the rear legs; and at no time was the tortoise observed to urinate on the eggs or ground. (It has been noted by other observers that urination is needed to insure sufficient moisture.) The digging and laying in each observed case was commenced in the late afternoon and on several occasions continued until after dark. Although it may not be significant, on two or three occasions, a male tortoise was observed standing nearby, facing the female, even after the other tortoises (5 to 7) had retired to their shelter for the night.

On June 28, 1949, tortoise No. 1 laid nine eggs; seven of these were removed from the ground and placed in a cardboard box (5″ x 8″ x 4″) on top of a water heater. A piece of tissue paper was placed over the eggs and once or twice a week a little water was sprinkled on the paper. No record was kept of the temperatures. On September 16, 1949, 80 days later, one of the eggs hatched. It was the egg farthest from the heat source. Three days after hatching, this tortoise was 38 mm. long (over-all shell length). On August 1, 1951, the length was 84 mm. and on July 21, 1952, 89 mm. with a carapace length of 86 mm. The first walking movements of the baby tortoise were very uncertain; it would take a step to the rear before starting off in the forward direction. On the second day, when offered food it seized a piece of clover in its mouth, held it down with a front foot and broke it with little hesitation.

In 1950, tortoise No. 1 laid nine eggs which were placed in a box under conditions similar to those used the previous year, but without success in hatching.

In 1951 the eggs laid by tortoise No. 1 were left buried in the ground, since it was thought that the warmer climate of Van Nuys might be satisfactory in hatching the eggs. None of the eggs hatched however.

On June 15, 1952, tortoise No. 1 laid seven eggs in a hole which she had dug. These eggs were removed and placed in an incubator made by Jack Cupp, one of my students. The incubator consisted of a wooden box 2 feet long, 1 foot wide and 9 inches deep. In the bottom of the box was placed an asbestos-covered heater. Over the heater was poured about a half-inch of sand on which the eggs were placed and these were then covered over with more sand. In the box was a thermostat and an open jar of water. Temperature readings during the incubation period indicated a minimum of 77° and a maximum of 94°F. Every week or ten days, about a tablespoon of water was sprinkled over the sand.

On the following dates, and after incubation periods as indicated, four of the eggs hatched: September 20 (98 days), October 4 (112 days), October 6 (114 days) and October 10 (118 days). The first tortoise to hatch seemed extremely immature. The rear of the shell was crushed in and the tortoise merely sat for five days. When it first started to walk the rear feet were continually stepping on the front feet. However, as of the time that this paper is being written, October 22, 1952, at the age of 32 days, this tortoise eats and walks as well as the other three and the shell has gained nearly normal form.

In five of the seven eggs, at various times after about the 80th day of incubation, a circular translucent area appeared in the top of the shell. This later proved to be an area above which the shell membrane had become detached. Records, for three of the eggs, of the first appearance of the translucent area in the top of the shell showed that in two it was evident 13 days before hatching, and in the third, 16 days. Only one of these five eggs failed to hatch, and upon being opened it was found that the fetus had died within, at most, ten days of hatching time. It may have been unable to break the shell.

On two occasions a small hole appeared in the shell the day before actual emergence. No activity was noted at the time the small openings were found; however, when the nose of the tortoise was touched through the opening, it was withdrawn. The dead fetus as well as the two tortoises were in an upside-

down position in the shell, and it is thought that they were probably all in this position before hatching.

Female tortoise No. 2 has been in captivity since 1934. Through study of old photos of the tortoise and through knowledge of early growth rates, it is estimated that in the fall of 1951 this tortoise was 20 or 21 years old. On July 21, 1952 she had a carapace length of 240 mm., height of 95 mm., and a maximum width of 188 mm. This tortoise has only four vertebral scutes instead of the usual five.

In 1949 tortoise No. 2 was observed to dig two egg holes, but no eggs were found. No digging was observed in 1950. In 1951 she dug one hole on May 27, one on the 29th and one on the 30th. On the 30th she laid five eggs—her first batch, as far as is known. (Conditions have been such as to permit close observation of her activities.) Digging commenced on the day on which tortoise No. 2 laid her first (presumably) eggs, just before noon in the heat of the sun; she was provided with shade after she started frothing at the mouth and nostrils. Four of the eggs were buried in the normal manner, and the fifth was laid on the surface after the others had been covered. The five eggs were then placed in a box on the water heater. This time the box was constructed in such a manner as to encircle the flue pipe. Temperatures observed by placing the end of a thermometer in the closed box ranged from 83° to 104°F.

On June 28, twenty-nine days after the first five eggs were laid, tortoise No. 2 laid two more eggs without burying them. These were marked and placed in the box with the first five. On June 29, three more were laid, two of which were broken. The one good one was buried with eggs laid by No. 1. On July 11, No. 2 dug a hole, and laid and buried three more eggs, bringing her total for the season to thirteen. No other tortoise has been observed to lay more than one batch of eggs in a single season. These last eggs were placed in the box with the others. The eggs of No. 2 were noted to be more elongated than those of Tortoise No. 1, the average dimensions being 43 mm. long and 33 mm. wide.

On August 23, 1951, 85 days after being laid, one of the eggs of the first batch hatched. Once again the only egg that hatched was the one farthest from the heat source. The other eggs in the box were opened after 190 days; all were found to be dehydrated except one; it was still fresh looking but the embryo was undeveloped.

In 1952, tortoise No. 2 failed to lay any eggs or dig an egg hole.

Woodbury and Hardy (1948, Ecol. Mon., 18: 145–200) introduced a key which uses a ratio of carapace height to shell length to separate *G. agassizi* and *G. polyphemus* from *G. berlandieri*. For *berlandieri* the ratio ranges from .47 to .56 as contrasted with a range of .36 to .48 for the other two. In the present study of two individuals of *G. agassizi* less than a month old, the ratio was .50. However, in one of these the tortoise is now over a year old and the ratio has changed to .47. A tortoise about a year old, found on the Mojave Desert, is also not in agreement with the proposed key; it has a ratio of .52.—George R. Stuart, *6308 Murietta Ave., Van Nuys, California.*

OBSERVATIONS ON THE FOOD OF THE LITTLE BROWNSNAKE, *STORERIA DEKAYI*, AT LONDON, ONTARIO.—During the period June 22 to August 2, 1952, ten specimens of the little brownsnake were collected in the late afternoon in an abandoned brickyard at the north-east corner of Adelaide and Cheapside Streets in London, Ontario. Scattered on the ground in this area were flat stones, piles of weatherworn boards, flattened cardboard-boxes, accumulations of loose bricks and other trash, and it was under these, in the drier parts of the brickyard, that the snakes were found.

Each captured snake was kept overnight in a glass jar. Fecal matter voided in the jar was collected and placed in preservative. The snake was killed in a cyanide jar and its length was measured. It was then dissected, and food material was removed, and preserved separately, from (1) the stomach and oesophagus, (2) the midgut, and (3) the hindgut. The samples were examined under a binocular microscope, some being mounted on slides in Canada balsam.

The food items were found embedded in greenish or brown masses of unrecognizable organic material, which occurred in sections along the length of the digestive tract, mainly in the midgut and hindgut. Such masses also composed the bulk of the fecal material. Most of the recognizable material consisted of hard parts remaining after the digestion of slugs and earthworms (Table I). The remains of slugs were shells, jaws and radulas; and the remains of earthworms were setae of various sizes. In addition there were mites, abdominal sclerites of a bug (Hemiptera), and the forewing of a plant bug (Miridae).

A search in the brickyard disclosed earthworms to be common in damp soil under shelters, and live slugs secreted during the day beneath shelters in the damper regions. Three species of slugs were found: *Deroceras reticulatum* (Müller) (Limacidae), *Arion hortensis* Férussac, and *Arion circumscriptus* Johnston (Arionidae), representative specimens of which were kindly identified by Dr. J. Oughton, Ontario Agricultural College, Guelph, Ontario. The slug of commonest occurrence in the brickyard was *D. reticulatum*. The only complete specimen of a slug retrieved from a digestive tract was one of *A. hortensis* found in the oesophagus of snake No. 8 (Table I).

TABLE I

IDENTIFIED MATERIAL FROM DIGESTIVE TRACTS OF TEN *Storeria dekayi*

No.	Date	Length, cm.	Stomach and oesophagus	Midgut	Hindgut	Feces
1	June 22	29.9	nil	1 radula, 1 shell	nil	4 radulas, 11 shells
2	June 25	23.5	nil	3 radulas, 4 shells, 1 jaw	1 radula	6 radulas, 9 shells, 1 jaw
3	June 26	18.6	nil	2 radulas, 3 shells, 1 jaw; segment of insect leg	1 shell	3 radulas, 5 shells, 5 jaws; 1 mite
4	June 27	33.9	nil	nil	3 radulas, 2 jaws	nil
5	June 30	34.9	nil	1 radula, 1 shell, 1 jaw; 1 mite	nil	nil
6	July 1	30.5	nil	nil	Many setae	nil
7	July 2	34.4	nil	nil	nil	nil
8	July 9	25.4	1 *A. hortensis*, 2 slugs; 1 tail end of worm	5 radulas, 1 shell	2 shells	1 radula, 2 shells
9	July 19	33.0	nil	nil	Integument of slug	nil
10	Aug. 2	31.9	1 anterior end of worm; many setae	Many setae; abdominal sclerites of hemipteran	nil	Forewing of bug (Miridae)

The slug shells found in the digestive tracts of the snakes were flat plates showing concentric lines of growth, thus resembling shells of the genus *Deroceras* as figured by Pilsbry (1948, Acad. Nat. Sci. Philadelphia, Monogr. 3, Vol. 2). The jaws were smooth, showing no ribs or striations. These features of the shell and jaws are characteristic of the Limacidae (including *Deroceras*) as opposed to the Arionidae (including *Arion*) and to the Philomycidae; the latter two families have representatives in Ontario (Oughton, 1948, Univ. Toronto Stud., Biol. Ser., 57). In the Arionidae the jaw is ribbed, and the shell is a plate without lines of growth (in *Arion*) or is a group of granules; while in the Philomycidae there is no shell and the jaw is striated or ribbed (Pilsbry, *op. cit.*). On the radulas in which the structure of the teeth was discernible, the lateral teeth were thorn-like, a feature of the Limacidae (Pilsbry, *op. cit.*). Shells and jaws of specimens of the three species of slugs found in the brickyard were dissected out and those from *D. reticulatum* matched those found in the snakes. Evidently then, most of the slugs eaten by the snakes were *Deroceras reticulatum* which was the species of commonest occurrence in the brickyard, although *Arion hortensis* was also devoured.

When the snakes were taken from their resting places, collections were also made of the following invertebrates which occurred commonly in those places: Centipedes.—*Lithobius* sp. (identified by key in Bollman, 1893, Bull. U. S. Nat. Mus., 46: 163–67). Woodlice.—*Armadillidium vulgare* L., *Porcellio rathkei* Brandt, *Oniscus asellus* L. (identified by key in Walker, 1927, Canadian Field-Nat., 41: 173–79). Snails.—*Anguispira alternata* (Say), *Pupilla muscorum* (L.), *Zonitoides arbore* (Say) (identified by Dr. J. Oughton, Ontario Agricultural College). Insects.—nymphs of crickets (*Nemobius* sp.), larvae of ground beetles (Carabidae), cocoons and adults of ants (including *Camponotus herculeanus* subsp.). No recognizable remains of these invertebrates were found in the digestive tracts of the snakes, although the invertebrates were readily available as food.

The food and feeding habits of *Storeria dekayi* have been discussed by several authors including Atkinson (1901, Ann. Carnegie Mus., 1: 148), Bishop (1927, New York State Mus. Handbook, 3: 89), Ditmars (1915, The reptile book: 268), Logier (1939, Roy. Ontario Mus. Handbook, 4: 31), Surface (1906, Zool. Bull. Pennsylvania Dept. Agric., 4: 139), and Williams (1913, The natural history of the Toronto region. Reptiles: 239), all of whom agree that this species of snake feeds on either slugs or earthworms, or on both, while some of these authors (Atkinson, Bishop, Surface, Williams) attest that insects are also eaten. The predominance of slugs and earthworms in the diet is evident in the sample of the ten snakes collected in London, but a few other invertebrates, e.g., mites and bugs, were included. In all of the snakes the oesophagus and stomach were either empty or contained undigested slugs and portions of earthworms, while in the midgut and hindgut digestion had proceeded to the point where only hard parts of the ingested animals were recognizable. The snakes were all captured resting under shelters in the late afternoon; and it is likely that the food was ingested during the night and was being digested while the snakes remained in hiding during the day. A considerable number of slugs could be undergoing digestion at one time, as evidenced by the presence of ten radulas and thirteen shells in snake No. 2.

During the dissection of snakes No. 5, 6, and 10, the midguts and hindguts were found to contain myriads of small wriggling worms. Some of these were sent to Dr. T. W. M. Cameron, Director of the Institute of Parasitology, McGill University, who identified them as nematode worms, *Rhabdias* (*fuscovenosa*?), and commented that they probably lived in the lungs of the snakes and were *en passage*

to the exterior where they have a free-living generation. When snakes No. 4, 5, 6, 7, and 9 were being dissected, it was noted that they were females containing 16, 12, 11, 13 and 15 embryos respectively, giving an average of 13.4 embryos per snake. These numbers fall within the range found by Clausen (1936, COPEIA (2): 98–102) in his study of the birth of young from a number of females of *Storeria dekayi*, for he concluded that "the number of young from each female varied from 9 to 20 with a mean of 14 for the group."—W. W. JUDD, *Department of Zoology, University of Western Ontario, London, Ontario.*

MYSTERY OF ALLEGED LIZARD EGG RESOLVED.—In "The Herpetology of the Cayman Islands" Chapman Grant (1940: 39) remarked that a glossy white egg with a hard, but profusely pitted, shell measuring 22 x 16 mm. had been given him by Mr. A. S. Rutty as being that of *Leiocephalus c. carinatus* Gray.

Specimens of this lizard from Cayman Brac, together with the egg, were received by the Museum of Comparative Zoology when this part of the Grant Collection was acquired. As the sheils of all known iguanid eggs are soft, geckos being the only lizards known to lay hard-shelled ones, we compared the Cayman Brac egg with that of a mud turtle (*Sternotherus odoratus*) which in shape and size it resembled but differed fundamentally in texture. The egg was then consigned to the unidentified tray.

A few years later, one of us (Loveridge) wrote to Mr. Rutty at Cayman Brac and asked for particulars as to how he came into possession of the egg. In his reply (May 7, 1947) he regretted being unable to shed further light on the matter, beyond assuming that it was one of many specimens brought in by natives for him to transmit to Major Chapman Grant. There the matter rested until the other day when one of us (Shreve) observed the photograph of Santo Domingo snail (*Pleurodonte*) eggs in Noble (1923, Natural History, 23: 112). We then consulted our malacological colleague, W. J. Clench. He promptly showed us the egg of a South American snail introduced into Jamaica that was so similar to Chapman Grant's egg we have no doubt but that it was laid, not necessarily on Cayman Brac, by a *Strophocheilus* snail and not by a *Leiocephalus* lizard.—A. LOVERIDGE AND B. SHREVE, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

NOTES ON THE NATURAL HISTORY, COLLECTION AND MAINTENANCE OF THE SALAMANDER *AMBYSTOMA MACULATUM*.—An intensive search for eggs and for breeding adults of *Ambystoma maculatum* (Shaw) was made through the countryside of eastern Massachusetts during the breeding seasons of 1949, 1950, and 1951, in connection with investigations in experimental embryology. In the course of collecting activities, and of using the animals in the Biological Laboratories at Harvard University, certain observations were made on the natural history, collection and laboratory maintenance of the species which may be of value to others interested in obtaining and maintaining embryos, larvae and adults.

COLLECTING SITES.—The most favorable sites located for collecting were two small unnamed woods ponds, one located in Milton, the other in Burlington, Massachusetts. Although similar in their general nature and topography, these two ponds differed markedly during the Spring in relative amounts of bottom weed growth. While the bottom of each pond consisted of a rather loose mud, the bottom growth at the Burlington site became markedly heavier than that at the Milton pond. While the former proved to be by far the richer source of adult animals during night collections, the eggs were much more easily obtained in the Milton water, where the clusters were not obscured by bottom growth.

TRAPPING OF ADULTS.—At the Milton site, a simple method of trapping adult animals during their migration to the breeding site was found useful. The general principle of the method was suggested to me by Mr. John N. Chase. Noble (1931, Biology of the Amphibia: 457) described a similar method used on a large scale for the collection of frogs commercially. Trapping is particularly useful in determining the approximate time of the first migration of the urodeles to the breeding site, so that one may be prepared for the collection of the earliest eggs; it is also useful in obtaining adult specimens in small quantity, since the trap can be visited in the daytime, after night movements of the animals have ceased.

The trap was built in the following way: Wire screening was placed over the four sides, the top, and the bottom of a wooden frame measuring approximately 12″ x 12″ x 8″. In one side, an oval opening was cut in the screening; the bottom of this opening could be made level with the ground surface by setting the trap in a shallow depression. From the opening, a wide funnel of screening led into the trap, arranged so that the inner end was about 2½ inches above the floor of the trap. A collar was placed about the inner end of this funnel as an aid to preventing escape of captured animals.

In the field, the trap was arranged so that the oval opening was directed away from the pond in an area relatively free of the very dense undergrowth which immediately surrounded the breeding site. From the sides of the funnel opening, strips of heavy waterproof paper (tar paper reinforced with fine wire) were arranged, directed away from the pond and up a slight incline, at an angle of ap-

proximately 45 degrees to the front of the trap. The paper strips were approximately ten inches wide, and were arranged perpendicular to the ground; they were held upright by small stakes driven into the ground at intervals on both sides of the strips. Along the bottom of the barriers, leaf mold was piled to prevent the urodeles from slipping under the tarred paper. The greater the length of the paper barriers, the greater the distance that separates their outer ends, and the greater the portion of the periphery of the pond that is covered. The efficiency of the method can be increased by increasing the number of traps.

The water behind the trap furnishes the bait, for as the urodeles crawl toward the pond during the rains of March nights, those issuing from their burrows in the area fronting the trap find their way along the barriers and into the funnel at the center. In my experience, the catch was not limited to *A. maculatum*. At different times, it included *Hemidactylium scutatum*, *Plethodon cinereus*, *Rana sylvatica*, and *Hyla crucifer*.

OBSERVATIONS ON THE EGGS.—The first eggs of *A. maculatum* for three successive seasons were obtained at the Milton site on the following dates: March 31, 1949; April 1, 1950; and March 20, 1951. These eggs had not yet passed through first cleavage at the time of collection.

Published observations by Gilbert (1942, Ecol., 23: 215–227) on the green coloration which one often notes in the egg masses of *Ambystoma maculatum* would suggest that presence of this coloration in late stages of development of the embryos of this species might be a key character in identification of its egg masses, and that the alga-egg relationship responsible for the color is one of symbiosis. That the character is of value in the identification of *A. maculatum* eggs only at late stages should be emphasized, for egg masses of this species obtained early in the season and taken into the laboratory for rearing from the pond in Milton, Massachusetts which harbored the implicated alga (probably of the genus *Chlorochytrium*, idem.), and egg masses deposited in the laboratory and kept there during development, have not been observed to display the green coloration, nor to contain the alga in the jelly. Egg masses containing the alga and demonstrating the green coloration when brought into the laboratory and placed in spring water have not lost the alga or coloration until hatching of the larvae. Perfectly normal embryos have been observed to develop in and hatch from egg masses lacking the alga, at rates and times comparable to those demonstrated by embryos of egg masses containing the alga. No apparent benefit from association with the alga has been observed to be derived by embryos the enveloping jelly of which contained the organism. It is probable that the alga-egg association depends not only on the presence of the alga in the water containing the eggs, but that it depends also on the egg jelly's attaining a certain degree of decomposition prior to the entrance of the alga into the various jelly envelopes.

LABORATORY MAINTENANCE OF ADULTS AND LARVAE.—Adult *A. maculatum* brought into the laboratory in the Spring of 1950 were kept in large aquaria containing standing tap water for a period of a few weeks, during which time a few spermatophores and egg clusters were deposited. Indoor breeding was not so satisfactory as obtaining the eggs in the field; indeed, bringing the animals indoors seemed to suppress the breeding activity since the majority of the animals attempted to leave the water provided. There appeared to be necessary a period of adjustment to new surroundings before any breeding took place in confinement, and the number of egg clusters obtained from a large number of male and female animals was very limited.

For use in the raising of *A. maculatum* larvae, a living food more convenient to supply than some of those commonly recommended (*Daphnia*, *Tubifex*, *Enchytraeus*, for example) is newly hatched *Artemia*. Eggs of this arthropod are available in large quantities, relatively inexpensively, in most shops handling supplies for the aquarium, as well as from biological supply houses, and a sufficient quantity of the crustaceans for a day's feeding of several urodele larvae may be hatched overnight in a 500-cc. beaker of sea water, natural or artificial. The newly hatched *Artemia* are small enough so that they are swallowed with ease by urodeles beginning to feed, while the *Daphnia* exoskeleton may tear the tissues of young *Ambystoma*. In addition, the use of *Artemia* for feeding young *Ambystoma* larvae permits avoiding the damage to *Daphnia* cultures attendant on straining out young stages of the latter as food for early feeding. The *Artemia* survive in the urodele culture medium (either saline solution or spring water) for a time sufficient for the urodeles to devour them, seeking, as the latter do, for moving food. Abundant food may be provided since the *Ambystoma* larvae appear not to overfeed on a diet of *Artemia*, yet *Artemia* alone provides a diet sufficient for the early weeks of larval life.—JAMES M. MOULTON, *Department of Biology, Bowdoin College, Brunswick, Maine.*

A SMALL COLLECTION OF REPTILES FROM CENTRAL KOREA.—The collection reported on here was secured by the author during the summer of 1952 while serving with the U. S. Army in Korea. No names of outfits will be mentioned for security reasons.

Nine snakes of four species, and two lizards of one species were collected, as well as a larger collection of amphibians which will be reported on sepa-

rately in a future paper. The area by far most thoroughly searched for specimens was 5.8 miles southwest of Inje in North Korea just a few hundred yards from the 38th parallel. Two small streams in this area that empty into the Soyang-Gang River from the south were searched very carefully on many occasions.

Collecting in other localities was of a more incidental nature. Mundung-ni, like Inje, is also in the east central sector, but about 25 miles north of the 38th parallel. Yanggu is directly south of Mundung-ni and about half-way between the latter and "the parallel."

A fairly detailed account of the reptiles collected is here offered because of the few publications on Korean reptiles in the English language and the few specimens available in American museums. Probably the largest collection in the country is the one in the California Academy of Science, reported on by Slevin (1925, Proc. California Acad. Sci., 14 (5): 89–100). The present collection will be deposited in the American Museum of Natural History.

Elaphe dione (Pallas).—One male, Seoul, Sept. 26, 1952; one female, 6.4 miles ESE of Mundung-ni at 3600 feet, Aug. 9, 1952. Both specimens agree in the following characters: scale rows 23–25–23–21–19; preoculars 1–1, plus a minute sub-preocular on both sides; postoculars 2–2; temporals 2 + 3–2 + 3; anal divided; supralabials 8–8. Infralabials are 10–10 in the male and 11–11 in the female. Ventrals are 188 and 202, caudals are 71 and 56, for the male and female respectively. Total lengths 406 and 377 mm., tail lengths 82 and 59 mm., tail length divided by total length .202 and .156 for the male and female respectively. Hemipenes extend to the 12th caudal on both sides in the male.

There are about 58 dark body bands in the male and 76 in the female. Dorsal and lateral light lines are present in the male and the body bands are often split into three parts in the region of the light lines; the ventral surface has a pattern of dark spots in three longitudinal series beneath the body, the lateral series darker, in two series beneath the tail. In the female the anterior surface of each ventral is mottled with black and forms only three distinct series on the anterior third of the body where the lateral series are darker. Two series are distinct beneath the tail.

Both specimens agree well in most characters with Schmidt's (1927, Bull. Amer. Mus. Nat. Hist., 54 (4): 467–551, 2 figs., pls. 28–30) and Pope's (1929, op. cit., 58 (8): 335–487) accounts of the variation shown by Chinese snakes except for the low caudal count in one specimen and the fewer (23) midbody scale rows in both. Pope's 13 specimens from the Peking and Tsinan regions are recorded as varying from 25 to 27 rows at midbody.

The Seoul specimen was found dead on a road (DOR); it contained mammalian remains in its stomach in the form of numerous grey hairs. The Mundung-ni specimen was taken on the summit of a mountain bordering the west side of the "Punch Bowl"; it lived among a tangle of roots and rocks.

Elaphe rufodorsata (Cantor).—Two males, 5.8 miles S.W. Inje, 700′, June 27 and July 6, 1952. Scale rows 21–19–17; preoculars 1–1; postoculars 2–2; temporals 2+3–2+3; supralabials 7–7 and 7–8; infralabials 10–10 and 10–9; anal divided; ventrals 162 and 167; caudals 57 in both specimens. Total lengths 479 and 481 mm., tail lengths 90 and 94 mm., tail length divided by total length .188 and .195, respectively. Hemipenes extend to the 10th caudal on the left and to the 11th caudal on the right side in one specimen; to the 11th caudal on the left and the 13th caudal on the right side in the other specimen.

Brown lateral and dorsolateral stripes are present, the latter breaking up into dark-brown bordered spots anteriorly. Very narrow dark brown markings are present on every one to three scales on all stripes. Belly heavily spotted with black spots, predominantly arranged into two lateral series. There is a dark irregular stripe composed of fused spots beneath the tail, centrally. The two specimens are similar in coloration.

Chinese specimens vary little except in ventral counts. Pope (1929, *op. cit.*) noted that northern Chinese specimens from Chihli and Shantung provinces averaged more ventrals (170.5 and 174.7 for Chihli and Shantung males, respectively) than males from Anhwei reported on by Schmidt (1927, *op. cit.*) which averaged only 166. The present Korean specimens agree more closely with the Anhwei series.

Elaphe rufodorsata.—This seems to be a semi-aquatic species, perhaps even more so than *Natrix t. lateralis*. One specimen was taken swimming in a stream, another from a small sandy and rocky island in the middle of a stream, and a third first seen out of water escaped under rocks in the stream. A toad, *Bombina orientalis*, was removed from the stomach of one specimen. This snake seems entirely inoffensive, for those collected never tried to strike or bite.

Natrix tigrina lateralis (Berthold).—Two females, 5.8 miles S.W. Inje, 700′, June 14 and 27, 1952; one male, 3 miles S.W. Mundung-ni, 1800′, Sept. 25, 1952; one male, 8 miles N. Yanggu, 1000′, Sept. 8, 1952. The Yanggu specimens was found DOR and is too badly crushed to record data on head plates and dorsal scales. Scale rows 19–19–17; preoculars 2–2; postoculars 3–3; temporals 1+2–1+2; supralabials 7–7, the third and fourth entering the orbit; infralabials are 9–10 in two snakes and 9–9 in one of the Inje specimens. The Yanggu specimen is included in the following data. Ventrals 160–161 and 163–166, caudals 65–69 and 56–63, for males

and females respectively; anal divided. Total lengths 590–707 and 571–776 mm., tail lengths 123–156 and 110–135 mm., tail length divided by total length .208–.221 and .191–.174, for males and females respectively. Hemipenes extend to the 12th caudal on both sides in the Mundung-ni male.

There are 40 black body bands in the Mundung-ni male and 45–54 in the Inje females. Red appears in the spaces between the first 19 bands in the two females and between the first 14 and 16 bands in the Mundung-ni and Yanggu males, respectively. Tail bands are too broken up and irregular to count accurately.

Schmidt (1927, *op. cit.*) gave the average number of ventrals for Anhwei specimens as 151 for males and 153 for females, and for northern specimens from Chihli, Shansi and Shensi as 153 for males and 157 for females. The trend is continued in Korean snakes with an average of 160.5 for males and 164.5 for females in the present collection.

This is undoubtedly the commonest snake in east-central Korea. Two other snakes of this species were seen by me at the Inje locality, and descriptions were furnished me of two others seen seven miles NNE of Yanggu.

All specimens were collected near streams, but the three that were found within a yard of water sought escape away from the stream into the bordering bushes. One snake actually crossed the shallow rocky stream and crawled rapidly onto the opposite bank in its effort to escape.

Agkistrodon halys brevicaudus Stejneger.—One female, 5.8 miles S.W. Inje, 700′, June 14, 1952. Scale rows 23–21–19–17–15, 21 at mid-body; preoculars 3–3; postoculars 2–2; temporals 1+1+1–1+1+1; supralabials 7–7, third contacting orbit; infralabials 10–10, first four contacting anterior chin shields; anal entire; ventrals 149; caudals 42. Total length 509 mm., tail length 69 mm., tail length divided by total length .136.

Body bands 27, tail bands indistinct. Color generally brown within the darker bordered bands. Bands separated laterally by a single scale length of yellowish-brown coloring.

Pope (1935, The reptiles of China: 390–98), agreeing with Thompson (1916, Trans. San Diego Soc. Nat. Hist., 2 (2): 61–76), placed all of the described races of the *halys-blomhoffi* complex into the synonymy of *Agkistrodon halys* (Pallas). Since then, *blomhoffi*, *brevicaudus* and *intermedius* have been recognized by Okada (1938) as races of *halys*. The author believes that at least these forms should be recognized, although the entire picture is far from clear and *ussuriensis* Emelianov and *stejnegeri* Rendahl (from Ussuri and China, respectively) may well be merely geographic variation gradients of *brevicaudus* Stejneger (type locality Fusan, Korea).

Okada (1938, A catalogue of vertebrates of Japan: 103) listed *intermedius* from Korea. This is almost certainly a mistake, for this name should be restricted to the race (with the high numbers of ventrals, dorsal scale rows, and supralabials) occurring to the west of the Khingan Mountains in Manchuria, Mongolia and Irkutsk (Stejneger, 1907, Bull. U. S. Nat. Mus., 58: 450–56; 464–65).

The single specimen collected was found on a very small loose rock and sand island in the middle of a shallow stream.

Eremias argus Peters.—Two young individuals, 12 miles E. Seoul, Sept. 17, 1952. Pattern of black bordered white spots. Subocular does not reach the lower labial border. Generally agrees with Schmidt's (*loc. cit.*) account of this species.

Collected in a drainage ditch by the side of the road. A single adult, probably of this species, from the same locality eluded capture.

I am indebted to Mr. Charles M. Bogert of the American Museum of Natural History for permission to examine Chinese specimens in his charge and to Mrs. Bessie K. Hecht of the same institution for incidental help and suggestions.—GEORGE D. STEWART, *49 E. Washington Avenue, Pearl River, New York.*

A LARGE LITTER OF COPPERHEADS (*AGKISTRODON CONTORTRIX MOKESON*). —A search of the literature reveals that the largest litter of copperheads recorded was composed of 12 individuals. On September 8, 1952, a 32-inch northern copperhead gave birth to 14 young, nine days after having been captured. The first born was observed on the floor of the cage at 7.25 PM, still in its membranous sack. At 10.47 PM the thirteenth snake was born; observations were continued for another hour, but no more young appeared. Sometime during that night the fourteenth and last snake was born. All were born alive except the twelfth; it came out head first and was devoid of the membranous covering. The average length of the young snakes was 9½ inches.—HENRY MOSKI, JR., *20 St. James Street, Hamden 14, Connecticut.*

A TIGER SALAMANDER, *AMBYSTOMA TIGRINUM*, FROM FRANKLIN COUNTY, TENNESSEE.—The available distribution records show that *Ambystoma tigrinum* has not been reported from the Appalachian region. Especially is this evident from the distribution map in Bishop's "Handbook of Salamanders" (160).

On December 11, 1952, a specimen was collected from the limestone quarry of the Marquette Cement Company, Cowan, Tennessee. A power shovel which was removing blasted rock to a conveyor belt unearthed this specimen. It was removed from the conveyor belt a fraction of a second before going into a rock crusher, by a local photographer who was in the neighborhood. After photographing

the salamander, he turned it over to us alive and in good condition.

This specimen, a male, with 2 plantar tubercles on each foot and 12 costal grooves, had a body length of 114 mm., tail 111 mm., and total length 225 mm. It weighed 62.7 g. and displaced 60 cc. of water.

Subsequent to the preparation of this note, two other specimens have been collected from the same locality.—H. MALCOLM OWEN AND HARRY C. YEATMAN, *Department of Biology, University of the South, Sewanee, Tennessee.*

RECORDS OF MARINE TURTLES IN THE NEWFOUNDLAND AREA.—Fishermen landed a "leathery" turtle, about six feet long and weighing about one thousand pounds, at Dunfield, Trinity Bay, Newfoundland, on August 24, 1946. It had become entangled in their long-line trawls and when towed ashore alive was accompanied by several unidentified fish, probably remoras. While we did not get an opportunity to examine this turtle, it was most likely the leather turtle, *Dermochelys coriacea* (Linné), previously reported as far north as Nova Scotia.

In the autumn of 1952 a fisherman reported seeing a large turtle, which he described as grey in color, near St. Mary's Bay on the southeast coast of Newfoundland. This may have been the ridley, *Lepidochelys kempi* Garman.

Casual reports of fairly small specimens of the red-brown loggerhead turtle also have come from fishermen on the Grand Banks in recent years. These reports were confirmed by a specimen (carapace only brought to the Newfoundland Fisheries Research Station, St. John's) which was taken on January 6, 1953, at Lat. 43° 24′ N. and Long. 51° 15′ W. This turtle, *Caretta caretta caretta* Linné., was trawled by the commercial dragger BLUE FOAM from a depth of about 100 fathoms, but was supposed to have been dead a few days and the carapace was cut away (the meat left on the carapace was only slightly decomposed). The carapace measured 59 cm. in total length and 50 cm. in breadth. There were 5 costal scutes and 12 marginal scutes.

Previous records in the literature give the range of the loggerhead turtle in the Western Atlantic as "north occasionally to the coast of Massachusetts" (Stejneger and Barbour, 1943: Checklist). Occurrences of strandings of this animal and of the ridley on the coasts of Great Britain and other countries of Europe have been attributed generally to the Gulf Stream drift, and the opinion has been expressed that these animals had crossed the Atlantic Ocean from the American coast (Parker, 1939, Proc. Linn. Soc. London, 151 (2): 127–29; Carr, 1942, Proc. New England Zool. Club, 21: 1–16; Wilson, 1947, Jour. Marine Biol. Assoc. United Kingdom, 27: 139–172). Our record would probably substantiate this opinion, since it might be presumed that if any of these subtropical animals penetrated as far north in the Gulf Stream as Newfoundland, some of them might be carried on in the currents and by winds toward Europe. Ordinarily they would avoid, perhaps, or would die in, the colder waters over the Grand Banks, but their presence in 1952 would coincide with a year of comparatively high temperatures in this area (Templeman, 1952, Ann. Rep. Newfoundland Fish. Res. Stat.: 6).

While the identity of the first two species of turtle mentioned could not be verified by examination, it seems probable that all three species occasionally reach as far north as Newfoundland.

The Newfoundland Fisheries Research Station acknowledges its indebtedness to Mr. Angus Pope, Mate, and Capt. Arch. Thornhill, Master, of the M. V. BLUE FOAM, who brought in the carapace of the loggerhead turtle, as well as, formerly, several specimens of deep-sea fish. Our record of the leather turtle was obtained from Mr. H. Brown, Bait Depot Engineer at Bonavista; and the report of the ridley, from Mr. Charles Price, fisherman.—H. J. SQUIRES, *Newfoundland Fisheries Research Station, Water Street East, St. John's, Newfoundland.*

A NOTE ON THE BURROWING HABITS OF THE SALAMANDER *AMPHIUMA MEANS MEANS*.—Bishop (1943, Handbook of Salamanders, Comstock Pub. Co., Ithaca) mentioned nothing about the burrowing habits of the congo "eel," *Amphiuma m. means*. In January, 1953, Mr. H. H. Burton, while operating a gasoline-powered tractor, plowed up from an estimated depth of three to three and one-half feet four living individuals of *A. m. means*. This occurred four miles east of Thomasville, Thomas County, Georgia, just off U. S. Highway 84. Two years prior to the extrication of these "eels" this place was a small bayhead with oak trees predominant. In 1951 Mr. Burton told me of seeing some large "eels" while he was clearing this bayhead for pasture development. At that time I requested him to save me any more eels that he happened to find. Mr. Burton presented me with the four individuals, one of which was preserved. It was a male 930 mm. in total and 218 in tail length and had 62 costal grooves.

The interesting points concerning these specimens are that (1) they occurred in pairs and (2) they had burrowed 3 to 3½ feet into damp soil which was firm enough to support a heavy farm tractor. How long they could have remained in this habitat during drier weather or how much farther they could have burrowed are matters for both investigation and conjecture.—JAMES C. KNEPTON, JR., *Wesleyan College, Macon, Georgia.*

Ichthyological Notes

NOTES ON THE AGE AND GROWTH OF THE PIRATEPERCH, *APHREDODERUS SAYANUS*, IN OKLAHOMA.—Sub-Prison Lake, a 60-acre impoundment four miles north of Stringtown, Atoka County, Oklahoma, was partially drained in December, 1950, and the remaining pool of approximately 10 acres was rotenoned by Oklahoma Game and Fish Department personnel. The appearance of large numbers of pirateperch, *Aphredoderus sayanus* (Gilliams), among other fishes along the shoreline was a complete surprise. Their presence was not indicated in a rotenone and seine check of the same lake made during the previous August, and prior to this work, the pirateperch had been found only farther east in swamps and roadside pools in McCurtain and Choctaw counties, and in a small tributary of the Kiamichi River, Pushmataha County.

Sub-Prison Lake is in the drainage of the North Boggy River, which flows about two miles to the west. The pirateperch probably entered the lake from that stream, during periods of overflow. The lake averages about four feet in depth, and at the time of the treatment, was slightly turbid and had an abundance of buttonbush, willow, and smart weed. Associated with the pirateperch in the fish population, in addition to the centrarchids (largemouth bass, white crappie, bluegill, warmouth; green, longear, redear, and orangespotted sunfishes) and ameiurids (channel catfish and black bullhead) usually found in southern Oklahoma lakes, were *Opsopoedus emiliae*, *Notemigonus crysoleucas*, *Pimephales notatus*, and *Etheostoma chlorosomum*.

Beyond the usual mention that the size seldom exceeds four inches, a search of the literature revealed nothing concerning the age and growth of the pirateperch. This study is based on an analysis of the scales of 82 fish 67 to 126 mm. in total length. Ages were determined by counting annuli on the scales at a magnification of 45×. Annuli on these elongated ctenoid scales were distinguished by a distinct separation between circuli in the anterior field, and a cutting across of circuli in the lateral fields.

Lengths were calculated to each annulus with the aid of a nomograph and an assumed zero intercept. Since all of the fish were taken in mid-December, the anterior edge of the scale was considered to represent a full year's growth. Thus, lengths of the fish in age-groups I, II, and III were calculated to the end of their second, third, and fourth years respectively (Table I). No young-of-the-year (one-year-old) pirateperch were obtained in this sample. The majority (58) of the 82 specimens were two years old. Nine individuals had lived through four growing seasons. The total length of the largest specimen examined was 126 mm. (5 inches). Within each age-group there was considerable length variation, which caused some length overlap between specimens of different ages. The rate of growth was most rapid during the first two years of life. The average total length of two-year-old fish was approximately 72 percent of the average length of four-year-old fish.

TABLE I

SUMMARY OF GROWTH OF 82 SPECIMENS OF *Aphredoderus sayanus* COLLECTED IN THE STRINGTOWN SUB-PRISON LAKE, ATOKA COUNTY, OKLAHOMA, DEC. 13, 1950

Age-group	Average* T. L., mm.	Length range	No.	Calculated T. L. at end of year of life			
				1	2	3	4
I	83.9	67–96	58	57.3	83.9†	....	....
II	99.6	82–110	15	55.5	86.4	99.6†	....
III	116.4	105–126	9	50.0	84.8	104.8	116.4†
Average length (mm.).....				55.8	84.5	101.6	116.4
Average length (inches).....				2.2	3.3	4.0	4.6

* T. L. = total length.
† Length calculated to December 13; all growth assumed completed for that year.

During development, the vent of *Aphredoderus* moves forward as the fish increases in size, reaching a jugular position in mature fish. Jordan (1878, Bull. Ill. State Lab. Nat. Hist. 1 (2): 37–70) studied the vent position in 26 *Aphredoderus* from 1 to 4¼ inches in total length and found it to be anterior to the pelvic fins in specimens three inches and longer. In all of the 82 Oklahoma specimens, the smallest of which was 67 mm. (2.6 inches), the vent had already moved to a jugular position, close behind the projecting knob at the isthmus.—GORDON E. HALL AND ROBERT M. JENKINS, *Oklahoma Fisheries Research Laboratory, Norman, Oklahoma.*

FOOD CONVERSION OF THE NORTHERN ROCK BASS, *AMBLOPLITES RUPESTRIS RUPESTRIS*, IN MICHIGAN.[1]—Laboratory experiments, that have established for warm-water fishes the relationship between the amount of food eaten and the amount of weight gained, have previously interested other fishery workers including Thompson (1941, *In:* A symposium on hydrobiology, Madison, Univ. Wis. Press, (1940): 206–17), Prather (1951, Trans. Amer. Fish. Soc., 80 (1950): 154–57), and Lagler and Kruse (1953, Jour. Wildlife Mgt., 17 (2): 219–21). The following food conversion ex-

[1] Contribution from the Department of Fisheries and Camp Filibert Roth, School of Natural Resources, University of Michigan.

periment on northern rock bass, *Ambloplites r. rupestris* (Rafinesque), was performed in July and August, 1952, at Camp Filibert Roth, field station of the University of Michigan's School of Natural Resources on Golden Lake, Iron County, Michigan.

The rock bass were taken from Golden Lake and kept individually in twelve glass aquaria, six of 15-gallon capacity, placed outdoors, and six of 3-gallon capacity, held in the laboratory. The tanks were kept full by constantly running water pumped from Golden Lake. The volume of flow was approximately equal for all containers. There was no way of measuring the plankton utilized by the experimental fish, but all individuals had the same opportunity. All tanks were covered with ¼-inch square galvanized iron screen. The average water temperatures during this period in the outdoor tanks was 70°F. (extremes, 67° and 75°) and in the indoor tanks 69°F. (range, 65° to 74°).

Rock bass normally feed upon insect larvae or nymphs, crustaceans, mollusks and fishes, as shown, for example, by Higgins (1933, Rept. U. S. Fish. Comm., (1932): 472) and Couey (1935, Trans. Wis. Acad. Sci., Arts and Lett., 29: 131–72). In order to compare conversion between the two major food groups, invertebrate and vertebrate, earthworms and rock bass flesh were fed to the experimental fish. These foods were chosen because of the facility with which they could be obtained in sufficient quantity throughout the course of the experiment.

All soil was washed from the exterior of the earthworms and the excess moisture was removed with absorbant toweling before they were used. The fish flesh was partly dried in the same manner. Items in both categories were then weighed in their moist, but not wet condition to the nearest 0.1 gram. It was found that the rock bass in one series would take worm-like strips of fish flesh almost as readily as those in the other series accepted the annelids.

Before weighing the live experimental fish, external moisture was removed by shaking them in air by hand. Weights were taken to the closest 0.1 gram at the beginning of the experiment, July 25, 1952, for most individuals, and again at the conclusion, August 27, 1952. Total lengths were measured to the nearest millimeter on a fishery measuring board at the same times.

The six fish on the diet of earthworms were divided equally between larger outside tanks and smaller indoor tanks. The fish on the diet of fish flesh were distributed similarly in the other six tanks.

Every other day the fish were fed as much as they would eat. If a piece of food was not consumed before the next feeding time, it was taken from the tank, dried to a condition approaching the moisture content of the original offering, and weighed. This quantity was subtracted from the weight of the original amount fed. A small error was doubtless introduced by this approach, at least for the fish flesh; this would normally lead to the subtraction of a weight that is slightly too small, as indicated by Larimore (1952, Jour. Wildlife Mgt., 16 (2): 131–38).

Water-mold developed on four fish in the outdoor tanks, two of which were on the earthworm diet and two on the fish diet. These individuals were discarded and replaced with fresh stock. Only eight specimens of the original twelve completed the 34 days of the experiment. Of these eight, the four on the earthworm ration had an average food conversion of 5.09 (range, 4.63 to 5.31) and the four on the

TABLE I

FOOD CONVERSION FACTORS AND RELATED GROWTH DATA FOR TWELVE ROCK BASS

Diet	Specimen Number	Time in days	Weight of rock bass (grams)					Total length of rock bass (mm.)			Food consumed			Food conversion factor
			Start	End	Gain	Gain per day	Gain, % of body wt.	Start	End	Gain	Total wt., gms.	Per day, gms.	% of body wt. per day	
Earthworm														
Outdoors	1	13	58.4	66.6	8.2	0.6	14	154	156	2	20.7	1.6	2.7	2.52
	3	34	101.6	150.3	48.7	1.4	48	189	196	7	225.4	6.6	6.5	4.63
	5	20	69.3	81.0	11.7	0.6	17	163	165	2	62.9	3.1	4.5	5.91
Indoors	7	34	83.6	116.6	33.0	1.0	39	178	181	3	175.1	5.2	6.2	5.31
	9	34	54.9	74.7	19.8	0.6	36	147	154	7	102.1	3.0	5.5	5.16
	11	34	36.7	51.7	15.0	0.4	41	139	144	5	78.8	2.3	6.3	5.25
Fish														
Outdoors	2	28	37.4	33.4	−4.0	....	....	134	133	....	0.0	....	....	....
	4	34	78.1	117.9	39.8	1.2	51	174	178	4	113.7	3.3	4.2	2.86
	6	20	71.5	83.2	11.7	0.6	16	163	165	2	43.6	2.2	3.1	3.73
Indoors	8	34	50.7	67.2	16.5	0.5	33	145	146	1	53.6	1.6	3.2	3.25
	10	34	40.7	48.3	7.6	0.2	19	137	138	1	42.7	1.3	3.2	5.62
	12	34	69.2	85.0	15.8	0.5	23	163	165	2	66.0	1.9	2.7	4.18

fish diet, 3.98 (range, 2.86 to 5.62) (Table I). The higher value for the earthworms may have been influenced by the inert soil material in their intestinal tracts. The factors were computed individually for all fish in the series at the termination of the experiment by dividing the weight of food consumed by the gain in weight (Table I).

Lagler and Kruse (*op. cit.*) found conversion factors of about 4 for the largemouth bass and about 3.5 for the smallmouth bass, by feeding live minnows in an experiment very similar to this one. Other conversion factors recorded in the literature for largemouth bass are approximately 4 (Prather, *op. cit.*) and 2.5 (Thompson, *op. cit.*).

Of the four replacement fish, two were in the experiment for 20 days, one for 28 days and one for 13 days. If these variables had not been introduced, a comparison could have been attempted between individuals in outdoor versus indoor, and in large versus small, tanks. The available data do not, however, indicate any marked differences between the subjects under the four conditions.

In the earthworm diet the greatest departures from the average conversion of 5 were shown by the replacement fish. Rock bass No. 5 showed only a small deviation but individual No. 1, which was held for the short time of 13 days, had a factor of 2.5 (Table I). With the foregoing as an exception, the fish diet showed much more individual variation in efficiency of conversion than did the earthworm food.

Although fish No. 2 refused to feed for the entire 28 days that it was held, it lost only four grams. Rock bass No. 6 was approximating the average conversion factor of 5 for its series near the end of the experiment.

If the percentage of the original body weight fed per day is computed from the average amount of food fed per day, the earthworm diet approximates 6 percent and the fish diet, about 3 percent, as calculated for the eight original fish.—KARL F. LAGLER AND WILLIAM C. LATTA, *Department of Fisheries, University of Michigan, Ann Arbor, Michigan.*

TWO SMALL TARPON FROM TEXAS.—The present status of the life history of *Tarpon atlanticus* presents an anomaly, namely, the presence of comparatively large numbers of adults with only scarce and scattered records of the young. In a way it is more peculiar that a few young are found now and then, than it would be if none was found. In that event we could rely strongly upon migration from an unknown breeding ground, but as matters stand we are not sure but what tarpon raise their young in some environment untapped by collectors that may be under our very eyes along the coasts of the Gulf states and Florida. Furthermore, the smallest specimens have mostly been found largely in shore ponds of rather high salinities, in the Bahamas and West Indies.

This note reports two small tarpon taken in Texas waters, one of which seems to be the smallest specimen extant. The smallest tarpon obtained by Breder (1944, Zoologica, 29 (4): 217–52) was 4.2 cm. in standard length and 5.3 cm. in total length. This fish was collected on Sanibel Island, Florida, on August 8, 1939, but it was ultimately lost in shipment and was not studied. The smallest tarpon examined by Breder was 5.4 cm. S.L., and he gave the following measurements (in percent of S.L.) for young 5 to 6 cm. long: head, 30–33; depth, 23.1–26.9; snout, 5.8–9.3; orbit, 6.5–9.3; maxillary, 17.1–20.2; interorbital, 3.6–6.3; pectoral length, 18.3–23.0; and length of last dorsal ray, 8.5–13.0. He counted each dorsal and anal ray as one and stated that in larger fish the first three or four rays are consolidated into one, but advised that in smaller specimens they should be counted. This was done with the specimens reported here.

Breder also quoted Fowler, who gave dimensions of the head as 25.0–30.8, and Beebe and Tee-Van, who recorded the dorsal length as 12–15 and anal base 19–23 (dimensions in terms of S.L.).

On November 18, 1950, at Flowing Well, a collecting station within the Aransas National Wildlife Refuge near Austwell, Texas, many cyprinodonts were taken in one minnow-seine haul. Two small tarpon in the net were immediately recognized and were preserved, merely as oddities, by the author and Mr. C. A. Schultz, as we had never before seen specimens this small. After the return to the Institute of Marine Science, these tarpon were brought to the attention of Dr. Gordon Gunter, who remarked that they were quite small and warranted investigation.

TABLE I

MEASUREMENTS AND COUNTS OF TWO SMALL TARPON FROM TEXAS

The measurements are in percentages of the standard length

Standard length, cm.	3.7	7.7
Total length, cm.	4.8	9.9
Dorsal rays	15	13
Anal rays	25	22
Lateral-line scales	42	42
Body, depth	24.3	19.2
Head, length	31.1	24.2
Snout, length	8.1	6.1
Orbit, length	8.1	5.1
Interorbital, width	5.4	4.0
Maxillary, length	8.9	12.1
Pectoral, length	16.2	13.1
Last dorsal ray, length	10.0	10.1
Dorsal fin, base	13.5	9.1
Anal fin, base	17.6	15.6
Pelvic, length	14.9	12.6

The station at Flowing Well was a certain spot within Mustang Slough in the Aransas National Wildlife Refuge, which lies on the mainland shore in Aransas County. This slough has a narrow connection with San Antonio Bay. The collecting station had a sandy-mud bottom with no vegetation in the water, although there were clumps of reeds along the shore. Little current was noted at the time, 5 PM, although there was slight wave action. The depth of the water was about two feet, with a temperature of 25.5°C. and a salinity of 31.8 *per mille*. This general area and its fish life have been described by Gunter (1950, Publ. Inst. Marine Sci. 1 (2): 89–101), with a map showing Mustang Slough.

The measurements of these two small tarpon, deposited at the Institute of Marine Science, are presented in Table I. I am indebted to Dr. Gunter for the measurements and counts of the larger fish. According to Breder's figures 3 and 7, the smaller of the two tarpon should be less than one year old. It was doubtless spawned the previous summer or fall, and a frail little fish of this size probably would not have traveled very far, although it might have come from the Gulf some ten miles away. The stomach of this specimen contained one *Membras vagrans* of 11 mm. T.L.—DONALD G. SIMPSON, *Institute of Marine Science, The University of Texas, Port Aransas, Texas.*

A NOTE ON THE SPAWNING OF *TILAPIA MOSSAMBICA* IN SEA WATER.—The African cichlid fish *Tilapia mossambica* (Peters) is becoming increasingly important as a pondfish in many tropical areas so that its present distribution is circumtropical. As the species was reportedly quite euryhaline and could also be pond raised in quantity, it seemed to possess some possibilities as a pond-reared baitfish for tuna. Fry of this species were secured in December, 1951, from the Department of Fisheries of the Colony of Singapore, where the species had been introduced, for experimental use by the Hawaiian Fish and Game Division. In order to ascertain if better growth would occur in salt water, where it was assumed reproductive activities would be inhibited, some of the offspring of the original stock were separated into two lots, one of which was maintained in sea water and the other in fresh water as a control. The difference between the growth rates of the two lots was not significant and fish of both lots spawned successfully. While this is an expected occurrence with *Tilapia* in fresh water, the spawning of this species in sea water was surprising. However, this species can survive in sea water of normal salinity for long periods of time.

Myers (1949, Aquarium Jour., 20 (6): 148) reported that the New York Aquarium maintained *Tilapia mossambica* in sea water for seven years, but made no mention of the species spawning in a marine environment. Schuster (1952, Indo-Pac. Fish Coun., Spec. Publ. 1: 107) mentioned that this species will spawn in either fresh or salt water without particular qualification, and since he discussed the fish in reference to a brackish water environment, some suspicion may remain that he had such an environment in mind.

The spawning of *Tilapia* in sea water occurred in a tank fed by a steady flow of water drawn from the supply of the Waikiki Aquarium which is also fed to the exhibition tanks where various marine fishes and invertebrates are held. Young *Tilapia* about 3 mm. in length were first noted on April 23, 1953. These were removed and placed in a small aquarium containing sea water. The pH of the water from which they were removed was 7.95 and the chlorinity was 19.29 p.p.m. This pH value is somewhat low for normal sea water which has a range of 8.1 to 8.3 but probably not low enough to be of significance; the chlorinity is, however, well within the range of normal sea water (Sverdrup, Johnson and Fleming, 1942, The Oceans, pp. 123 and 195). Additional young, left with the adult fish, were noted on May 6 and again on May 12, 1953; the length of the first of these lots was estimated to be 5 mm. and the second, 3 mm. The batch of young in the small aquarium grew rapidly, the estimated size being about 12 mm. on May 21, 1953, when they were transferred without loss to fresh water. The adults and young yet remaining in sea water at the Waikiki Aquarium were also abruptly transferred, without significant loss, to fresh water at this time. However, some young, about 5 mm. in length, born in fresh water did not survive immediate transfer to full strength sea water.

I wish to thank Mr. Spencer Tinker, Director of the Waikiki Aquarium, for the provision of a tank in which the *Tilapia* were held in sea water.—VERNON E. BROCK, *Division of Fish and Game, Territory of Hawaii, Honolulu 1, Hawaii.*

NOMENCLATORIAL NOTES ON TEXAS FISHES OF THE GENUS *NOTROPIS*.—Both of the type series of the nominal species, *Cyprinella texana*, and *Moniana deliciosa*, described by Girard (1856, Proc. Acad. Nat. Sci. Phila.: 198–200), include two currently recognized species. The selection of a specimen of one of the two species in both series as the lectotype would necessitate nomenclatorial changes according to the current Rules, while selection of a specimen of the other species as type would result in no changes. The largest specimen of both nominal species not only reasonably fits Girard's printed description, but also its selection as type will result in nomenclatorial stability.

The *Cyprinella texana* type series in the National

Museum contains six specimens; four are members of the species now called *Notropis venustus* and two are *Notropis deliciosus*. Hubbs and Ortenburger (1929, Univ. Oklahoma Bull., 1: 68) identified the *N. deliciosus* specimens as *N. volucellus*. Both Leonard P. Schultz and Ernest A. Lachner identified them as *N. deliciosus*. Girard's description fits *Notropis venustus* better than *N. deliciosus*. As the three names were proposed by Girard, 1856, in the following page or line sequence, *venustus*, *texanus*, and *deliciosus*, a specimen of *N. venustus* is selected as lectotype and as such retains the original catalogue number (USNM No. 128). The other three *N. venustus* in the type series become paratypes (USNM No. 162721) and the two *N. deliciosus* are recatalogued as USNM No. 162722.

The types of *Moniana deliciosa* in the U. S. National Museum are also a complex: two specimens are identified as the species now called *Notropis deliciosus* and nine are *Notropis volucellus*. Girard's incomplete description does not exclude any specimen from consideration as type. As the name *deliciosus* has priority over the name *Notropis volucellus* (Cope, 1864, Proc. Acad. Nat. Sci. Phila.: 283), and the name *deliciosus* has been associated with the species represented by the largest specimen of the type series, I designate that specimen as lectotype. It retains the original catalogue number (USNM No. 119). The remaining *N. deliciosus* specimen becomes a paratype (USNM No. 162723) and the nine other specimens are recatalogued as *Notropis volucellus nocomis* (USNM No. 162724).—Clark Hubbs, *Department of Zoology, University of Texas, Austin, Texas.*

RELATIONSHIP OF LENGTH OF FISH TO INCIDENCE OF SEA LAMPREY SCARS ON WHITE SUCKERS, *CATOSTOMUS COMMERSONI*, IN LAKE HURON.—During the course of experimental fishing operations conducted by the staff of the Hammond Bay Fishery Laboratory (a field station of Great Lakes Fishery Investigations) in 1950–51, length measurements and records of scarring incidence and number of scars per individual were obtained for a sample of 552 white suckers, *Catostomus commersoni* (Lacépède). The fish were captured during the period February 26 to April 16, 1951, in trap nets of which all but one were of conventional Great Lakes design. The exception was an experimental type, of substantially smaller dimensions than the conventional nets and with 1-inch mesh, extension measure, in the pot. In the standard net the mesh size in the pot was 3 inches. Although the entire sample came from nets fished under the ice in 10 to 20 feet of water in Duncan Bay on the eastern edge of Cheboygan, Michigan, we believe, on the basis of our other fishing operations, that these fish are reasonably representative of the white sucker population of the general area.

Length in Relation to Percentage of Scarring.—The upward trend in the percentage of white suckers bearing sea lamprey scars with increase in the length of the fish is readily apparent (Table I and Fig. 1). At lengths below 11 inches the percentages were consistently small—nil to 16.4. Scarring incidence rose above 25 percent at 11.0–11.9 inches (26.3 percent scarred), passed the 50-

Table I

Relationship of Length of White Suckers to Incidence of Scarring by Sea Lampreys and Distribution of Scarred Fish According to Number of Scars per Individual

Total length (inches)	Total number of fish	Number of fish scarred	Percentage scarred	Number of scars				
				1	2	3	4	5
5.0–5.9	8	1	12.5	1	...	...	...	...
6.0–6.9	25	2	8.0	2	...	...	...	...
7.0–7.9	15	...	0.0	...	...	...	...	...
8.0–8.9	10	1	10.0	1	...	...	...	...
9.0–9.9	23	2	8.7	2	...	...	...	...
10.0–10.9	55	9	16.4	9	...	...	...	...
11.0–11.9	114	30	26.3	27	3	...	...	...
12.0–12.9	138	55	39.9	46	7	2	...	...
13.0–13.9	82	38	46.3	29	9	...	...	...
14.0–14.9	48	30	62.5	22	5	1	2	...
15.0–15.9	15	10	66.7	5	5	...	...	...
16.0–16.9	7	5	71.4	3	1	...	...	1
17.0–17.9	7	5	71.4	3	1	1	...	...
18.0–18.9	1	...	0.0	...	...	...	...	...
19.0–19.9	3	3	100.0	...	3	...	...	...
20.0–20.9	1	1	100.0	...	...	1	...	...
Total number ..	552	192	34.8[1]	150	34	5	2	1
Average length..	11.9	13.1	...	12.7	14.2	15.0	14.0	16.0

[1] Grand average percentage of scarring.

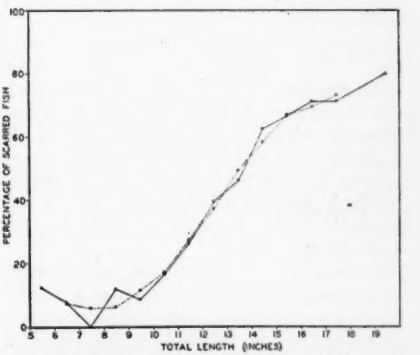

Fig. 1. Regression of scarring incidence on total length of white suckers in northern Lake Huron, 1951. The solid line represents the percentages as given in Table I (except that the data for the 5 largest fish were combined to obtain the percentage of 80 for the length range 18.0–20.9 inches). The broken line shows the same data, smoothed by a running average of three.

percent level at 14.0–14.9 inches (62.5 percent scarred), and continued to increase to 71.4 percent at 16.0–17.9 inches. Among the 5 largest suckers 4, or 80 percent, had suffered attacks from sea lampreys (this figure of 80 percent was plotted in Fig. 1 as representative of fish over the length range 18.0–20.9 inches).

This trend is brought out even more sharply by the condensed data of Table II. Here it may be seen that the scarring incidence was 11.0 percent for white suckers less than 11 inches long, 40.1 percent at 11.0–14.9 inches, and 70.6 percent at 15.0–20.9 inches.

Despite numerous irregularities, to be attributed largely to small numbers of fish at certain lengths, the curve of regression of scarring incidence on length of fish (Fig. 1, solid line) shows a distinct tendency to be sigmoid. This characteristic of the regression is brought out more clearly when the original percentages are smoothed by a running average of three (broken line). In the computation of the percentage for the last point on the smoothed curve, the value of 80 percent for suckers over the length range 18.0–20.9 inches was given a weight of only 0.5 as compared with weights of 1.0 for the percentages at 16.0–16.9 and 17.0–17.9 inches.

The following factors are believed to have contributed to the observed increase in the incidence of sea lamprey scars with increase in the length of white suckers: mechanical difficulties of attachment of a sea lamprey to a small fish; increase, with increase in length of white suckers, in the probability of surviving a sea lamprey attack; the greater length of time the larger (and presumably older) suckers had been exposed to the danger of attack.

Inasmuch as we are without good information from which to judge the relative importance of the factors listed above, any further discussion of them would be little to the point.

Length in Relation to Number of Scars.—Of the 15 white suckers less than 11 inches long that had suffered sea lamprey attacks, all bore a single scar (Tables I and II). At all lengths above 11 inches, however, some fish carried more than one scar (the single fish at 18.0–18.9 inches had not been attacked). In the entire sample, 150 white suckers had suffered a single sea lamprey attack, 34 had been attacked two times, 5 three times, 2 four times, and 1 five times.

The incidence of multiple scarring tended strongly to increase with increase in the length of the fish. As was stated above, only single scars were observed at lengths below 11 inches. Over the range 11.0–14.9 inches, 19.0 percent of the marked fish had experienced two or more attacks, and at 15.0–20.9 inches 54.2 percent of the marked suckers exhibited multiple scarring. This same trend is apparent from the following record of the number of sea lamprey marks per scarred individual at different lengths: 5.0–10.9 inches, 1.00; 11.0–14.9 inches, 1.52; 15.0–20.9 inches, 1.75.

Table II

Percentage of Scarred White Suckers and Incidence of Single and Multiple Scars for Three Intervals of Length

Item	Total length (inches)			Total or Average	Average length
	5.0–10.9	11.0–14.9	15.0–20.9		
Total number of fish	136	382	34	552	11.9
Number of fish scarred	15	153	24	192	13.1
Percentage scarred	11.0	40.1	70.6	34.8	...
Fish with single scars					
Number	15	124	11	150	12.7
Percentage of all fish	11.0	32.5	32.4	27.2	...
Percentage of scarred fish	100.0	81.0	45.8	78.1	...
Fish with multiple scars					
Number	...	29	13	42	14.3
Percentage of all fish	...	7.6	38.2	7.6	...
Percentage of scarred fish	...	19.0	54.2	21.9	...

The same factors listed in the preceding section in explanation of the regression of scarring incidence on length of fish (without reference to number of scars) no doubt contributed to the observed relationship between fish length and the occurrence of multiple scars.

Conclusion.—If information on the incidence of sea lamprey scars on white suckers in northern Lake Huron is to be used to judge the relative abundance of sea lampreys and the damages inflicted by that parasite on the sucker stock, data must include records of the lengths of fish. It is to be suspected strongly that a similar conclusion applies in other localities and to other species preyed upon by the sea lamprey.—A. E. Hall, Jr., and Oliver R. Elliott, *U. S. Department of the Interior, Fish and Wildlife Service, Rogers City, Michigan.*

TWO NEW RECORDS OF FISHES (*PALINURICHTHYS, CHEILODIPTERUS*) FROM FLORIDA AND THE GULF OF MÉXICO.—Recently the Ichthyology Collection of the University of Miami received a specimen each of *Palinurichthys perciformis* (Mitchill) and *Cheilodipterus affinis* Poey.

The specimen of *Palinurichthys perciformis*, 745 mm. in standard length, was a gift of Mr. Al Pflueger. The fish was caught by commercial fishermen off the coast of Key West, Florida, during early February, 1953, in approximately 100 fathoms of water. It represents a southward extension of about seven hundred miles for the known range of the

species, which heretofore was recorded only as far south as Cape Hatteras.

The specimen of *Cheilodipterus affinis*, 70 mm. in standard length, was obtained by Mr. Isaac Camber from the stomach of a red snapper, *Luljanus aya*, caught off the coast of Campeche, México, during December, 1951. The condition of the specimen indicates that it must have been ingested just a short time prior to its removal. This species was formerly known from only three specimens taken off the coast of Havana, Cuba. Dr. E. A. Lachner of the U. S. National Museum, who kindly verified the identification with Poey's cotypes, wrote that two or three additional specimens had been sent to the National Museum from the West Indies, but that the disposition of these specimens was unknown at this time.—VICTOR G. SPRINGER, *University of Miami, Coral Gables, Florida.*

FIRST RECORD OF THE BLACK CRAPPIE, *POMOXIS NIGROMACULATUS*, IN MAINE.—A black crappie, *Pomoxis nigromaculatus* (LeSueur), was taken from Sebago Lake, Maine, in a gillnet set by personnel of the Maine Department of Inland Fisheries and Game in August, 1952. Since that time the writers have identified at least three other specimens taken from the same waters by anglers. Hubbs and Lagler (1947, Fishes of the Great Lakes Region, p. 94) did not include Atlantic slope waters north of North Carolina within the natural range of this species.

Investigation of the appearance of the black crappie in Sebago Lake uncovered the interesting information that these fish were reportedly stocked in Virginia Lake in Stoneham, Maine, in 1921. The removal of the fish screen from the outlet of Virginia Lake in 1945 may have been the beginning of a long migration that eventually ended in Sebago Lake. By 1948 and 1949, specimens were being taken by anglers from Kewaydin Lake and Proctor Pond, both accessible from Virginia Lake via the outlet, Mill Brook. Mill Brook eventually flows into Crooked River, one of the major tributaries of Sebago Lake.

Local anglers have "identified" the crappies as bluegill, *Lepomis macrochirus*, or as hybrids between the white perch, *Morone americana*, and the pumpkinseed sunfish, *Lepomis gibbosus*.

Present information indicates that the black crappie has become established in Maine waters.—STUART DEROCHE AND ROBERT FOYE, *Maine Department of Inland Fisheries and Game, Augusta, Maine.*

A NATURAL SPAWN TAKER.—A striking example of animal ingenuity was revealed upon a visit to a weir at the outlet of Phelps Lake in Grand Teton National Park, Wyoming, on May 28, 1953. A large female cutthroat trout (*Salmo clarki lewisi*), nearly dead, was found in the trap floating on the surface of the water. Examination of the fish revealed that her head had been crushed in on one side, exposing the brain cavity. The brain itself was nearly destroyed and the eye of that side was missing. The vent of the fish had been torn open in a manner that would allow free removal of the ova. Along the belly of the fish was a set of deeply penetrating claw marks clearly indicating that the attacker had forced the eggs down the body cavity to the enlarged vent in much the same manner that a spawn taker uses in stripping eggs.

No animal was seen at the time of the investigation but all signs indicated that the predator was a mink, and one had been observed within 300 yards of the trap a day earlier. That the animal recognized the fish to be in a gravid condition, and its methodical method of immobilizing the fish and subsequent removal of the eggs without tearing into the flesh, is quite remarkable. The egg removal was very complete, for only about two dozen ova remained in the body cavity. The intruder was apparently satiated with only the eggs since no other part of the carcass had been fed upon.—HAROLD K. HAGEN, *Grand Teton National Park, Moose, Wyoming.*

A SECOND INSHORE RECORD OF THE BATHYPELAGIC VIPERFISH *CHAULIODUS MACOUNI* FROM BRITISH COLUMBIA.—A second inshore specimen of *Chauliodus macouni* Bean was taken in a trawl net off Canoe Pass buoy at the mouth of the Fraser River, between 58 and 60 fathoms. The fish was caught on March 4, 1951, by Mr. W. Falconer, captain of the trawler TORDO. This and the first inshore record in 1947 (Barraclough, 1950, COPEIA (3): 241) are most unusual, since the fanged viperfish is ordinarily taken only in offshore waters and is recognized as a bathypelagic species.

Fin-ray counts, photophore counts and body measurements are as follows: Standard length, 148 mm. Length to origin of anal fin, 125 mm. Predorsal length, 39 mm. Head length, 22 mm. Length of snout, 5.5 mm. Diameter of eye, 5.0 mm. Proportions in standard length: snout to origin of dorsal, 3.8; length of head, 6.4; snout to origin of pelvics, 2.3; snout to anal, 1.2. Proportions in length of head: diameter of eye, 4.4; length of snout, 4.0. Fin rays: D. 5; A. 11; P. 12; V. 7. Number of photophores: O–V, 18; V–A, 27; total in lateral row, 45; I–P, 9; P–V, 21; V–A, 28; A–C, 12; total in ventral row, 70; branchiostegal series, 19. There are 2 photophores in each section of the main row of smaller photophores, in the area between the longitudinal rows of large photophores.

Reasons for retaining this form as a full species (rather than as a subspecies of *C. sloanei*) are given in the earlier article, and the above data serve to further support this conclusion.—W. E. BARRACLOUGH, *Fisheries Research Board of Canada, Pacific Biological Station, Nanaimo, British Columbia.*

REVIEWS AND COMMENTS

THE FROGS, TOADS, AND SALAMANDERS OF EASTERN CANADA. By E. B. S. Logier. Clarke, Irwin, and Company Limited, Toronto, 1952: xii + 127, frontis., pl. I–V, fig. 1–57, $3.75.—. This small book combines an introduction to the biology of the Amphibia with a useful field guide to the frogs and salamanders of eastern Canada. The region treated includes all of Ontario, Quebec, Labrador, Newfoundland, and the Maritime Provinces. The first half of the book deals with amphibian biology in a simple and interesting manner. Among the topics treated are structural features, life history, geographic distribution, economic importance, and techniques of collecting and preserving. The remainder of the book treats individually the twelve salamanders and fourteen salientians known from the area under consideration. Keys are provided and are generally satisfactory; although some of the couplets—for example the one separating the two-lined and dusky salamanders—are not well chosen. There is little discussion of geographic variation especially among the salamanders. This is unfortunate in the case of such forms as *Necturus*, *Triturus*, and *Ambystoma jeffersonianum* where analysis of variation in Canadian material would be very helpful. There is seemingly an inconsistency in the conservative taxonomic treatment given *Rana pipiens* and *Rana sylvatica* and the recognition of the very weak race of the two-lined salamander, *Eurycea bislineata major*. Although some information is given on modifications of amphibian life cycles to meet the rigorous climatic conditions of Canada, one wishes more material of this nature had been included. The four plates depicting frogs are attractive, and the numerous line drawings contribute to the usefulness of the work. Range maps for at least some of the species would have been a worthwhile addition. Beginning students of amphibians and those with broad fields of interest in biology and conservation will find this book helpful and easy to use. Many herpetologists will feel that it gives no more than routine treatment to an interesting assemblage of species.—SHERMAN A. MINTON, JR., *Indiana University Medical Center, Indianapolis, Indiana.*

FAUNAL AND ARCHEOLOGICAL RESEARCHES IN YUCATAN CAVES. By Robert T. Hatt, Harvey I. Fisher, Dave A. Langebartel and George W. Brainerd. Cranbrook Institute of Science, Bull. 33, Bloomfield Hills, Mich., 1953: 1–119, 33 figs., 3 maps, $2.50.—Parts 1 and 2 by Hatt include a discussion of earlier Yucatan cave studies, physical geography of the Yucatan Peninsula, description of the 14 caves visited, check-lists of identified remains, a check-list of mammals of the Yucatan Peninsula, an annotated list of mammals from the caves, and a general analysis. Parts 3, 4 and 5 treat bird remains by Fisher, reptiles and amphibians by Langebartel, and archeological findings by Brainerd. Late Pleistocene is the maximum age of the collections, and the majority are contemporaneous with ceramic deposits dating from 300 B.C. to the present. Mammals are the group best represented although 189 reptile and 13 amphibian determinations, mainly generic, were made. Langebartel describes two new lizard genera, an iguanid and a xantusid, of "early post-Pleistocene" age.

Compared with those of the West Indies, Middle American cave deposits have suffered serious neglect. The remarkable recoveries from San Josecito Cave and a few others in northeastern México are the best known to date, and unfortunately these were not all studied with proper regard to stratigraphic sequence. Hatt's field work is exemplary in this respect as his lots are carefully related to depth of deposit and any associated artifacts.

Thus it is especially disappointing that despite some 3,300 identifications, careful collecting technique, and the discovery of two undescribed genera, only four other animals unknown to the recent fauna of the cave area were found. Without a larger faunal sample the presence of late Pleistocene climatic fluctuations as recognized by Sears in the Valley of México can not be determined. The absence from the deeper deposits of various humid tropical forest dwellers, such as monkeys, the kinkajou and the white-lipped peccary is also notable, and contradicts the popular hypothesis that

some form of tall evergreen forest existed about the caves in precultural Yucatan.

As a guide post for further Yucatan studies, and an inspiration for careful subfossil collections elsewhere in the tropics, this report is welcomed. Any solutions to the challenging problems of tropical Pleistocene biogeography will be realized only after many more painstaking investigations of this nature.—PAUL S. MARTIN, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

SOCIAL BEHAVIOR IN ANIMALS with special reference to vertebrates. By N. Tinbergen. Methuen & Co., London, John Wiley & Sons, New York, 1953: 150 pp., 67 text-figs. $2.50.—A simple and interesting presentation of the current status of the activities of the Lorenzian school of animal behavior. It is directed primarily to amateurs, including zoologists not primarily concerned with social behavior. The writing is clear, concise and to the point. The illustrations are for the most part attractive and well chosen. For anyone not familiar with the field it can be thoroughly recommended for a quick survey, which is what it is clearly intended to be. The final chapter is a direct appeal, with suggested methods and procedures, for amateurs, in the above sense, to undertake research in this field. The studies cover both intra- and extra-specific social relations and social organizations including their evolutionary aspects, all discussed in terms of the sequential releasers of Lorenz. Examples from each vertebrate class and some invertebrates are discussed in reference to comparative behavior. Somewhat less than half of the book considers the cold-blooded vertebrates, most of which is about fishes.

Although the appended bibliography of 119 titles was admittedly greatly condensed, it is rather disappointing to find that the most recent reference to American work on fishes appeared in 1939, the most recent work on reptiles appeared in 1934, and no American work on amphibia was mentioned at all. Another rather surprising omission, in a book on social organization which discusses fishes to such a considerable extent, is the complete absence of any discussion of the fish school. The somewhat similar appearing but temporary closely knit flocks of starlings are discussed briefly. The pioneer work of Parr on fish school constitution appeared in 1927. Smaller items of disagreement quickly descend to quibbles not worth committing to paper. It may not be out of place to note that the book contains considerable interpretation of observed phenomena, much of which is controversial in nature and involves the semantics of animal behaviorists. Many would think some of the passages anthropopathic, some of which are in single quotes and some not, but viewed in the light of the expressed intent of the writer they should be considered as a concession to the audience for which intended.

The reviewer found especially interesting the implications inherent in the discussion of the little understood manner in which individuals instantly recognize other individuals in various animal groups as apart from the stylized signals by which, for example, males may be told from females. Also most satisfactory is the emphasis on the necessity of understanding the general normal behavior pattern of the species in question before an investigator can expect to make valid interpretations of isolated behavior phenomena either under experimental conditions or by simple field observation. The need for criss-cross references between the artificial restrictions which laboratory or field experiments impose and the behavior of the feral individuals acting in reference to the totality of their normal environment without added constraints is also suitably indicated.—C. M. BREDER, JR., *The American Museum of Natural History, New York 24, N. Y.*

FISHERY SCIENCE: ITS METHODS AND APPLICATIONS. By George A. Rounsefell and W. Harry Everhart. John Wiley & Sons, Inc., N. Y., 1953: xii + 444 pp., illus. $7.50.—This is the second English textbook on fishery biology to appear within the last two years and is the first to include both freshwater and marine fishery biology.

The book is divided into 11 sections, has 25 chapters, an appendix, glossary, and index. The 11 sections are: Road to management (2 chapters), Natural populations (5), Fish ponds (2), Fishing gear (1), Protection against hazards (3), Improvement of habitat (2), Tagging of fish (2), Age and growth (2), Collecting basic data (2), Managing natural populations (3), and Problems (1). The appendix is a list of fishery organizations and their journals. A bibliography follows each chapter. The illustrations are generally well chosen and pleasing, with the exception of the single color plate which seems to have suffered somewhat in the printing process.

The authors share the rather universal opinion that fishery biology is an applied science (the term "fishery management" is used extensively throughout the text to the virtual exclusion of "fishery biology"). This view is prevalent among fishery biologists employed by both governmental agencies and universities, even though many of the principles concerning the population dynamics of fish populations (the main problem of fishery biology) have not yet been discovered and, obviously, cannot therefore be applied to specific situations.

The first chapter, "How do we produce knowledge?," is a discussion of the scientific method. The fact that such a discussion is included at all is

significant in itself and this chapter could well be reviewed by all interested in the field.

The system of notation used in connection with vital statistics is almost entirely new. It is unfortunate to introduce another set to an already large body. Surely it would have been better to adopt those symbols already in fairly wide use.

Some of the other additions or corrections which would improve this text are: The references are largely, although not entirely, restricted to North American works. More adequate coverage of the non-North American literature would be of value. While the authors have correctly pointed out the effect of a positive or negative y-intercept in the regressions used to estimate the size of fish at previous ages, they have incorrectly used the regression of scale length on fish length. The reverse should be used, since fish length is estimated from the observed scale length. Year-class catch curves (age frequency distributions) are not discussed, whereas their use obviates some of the difficulties the authors mention in connection with season catch curves.

We may expect this text to be rather widely adopted by colleges and universities offering courses in fishery biology. It is the best presently available, not only in breadth of subject matter, but in attention to principles insofar as these are known.—JOHN C. MARR, *U. S. Fish and Wildlife Service, 450-B Jordan Hall, Stanford University, California.*

TROUT. By Ray Bergman. Alfred A. Knopf, New York, 1952: xv + 482 + xiii pp. (index), numerous illustrations (including 21 color plates). $7.50—This is the second edition of the popular angling book on trout revised and enlarged since the original edition was published in 1938.

The book starts with seventeen beautiful color plates of wet and dry flies, two of spinning lures and one of fly-tying feathers, all by the late Dr. Edgar Burke. Then comes a chapter entitled "Early Experiences" which explains how the author became interested in fishing and in writing about it. Chapters on the tackle and methods of fishing with wet flies, nymphs, streamers, dry flies and spinning lures are detailed and explicit. The writer's vast and varied experiences in all types of trout fishing everywhere on the North American continent are cited to illustrate the effectiveness of the different methods. Special problems encountered in fishing for trout are discussed such as the ideal trout day ("Sunshine and Shadow"), water types and how to fish them, vision of trout and the types of rises of trout, etc. Special chapters on the steelhead, lake trout and the grayling follow. The final section of the book is devoted to a well-illustrated chapter on fly-tying methods and to a detailed description of the materials needed to tie the flies shown in the color plates at the front of the volume.

Fish biologists are often asked to recommend a book for the beginner in angling or as a gift for an experienced trout fisherman. I don't know of a better choice for either than *Trout.*—ALBERT S. HAZZARD, *Institute for Fisheries Research, Ann Arbor, Michigan.*

MARINE GAME FISHES OF THE WORLD. By Francesca La Monte. Doubleday and Company, Inc., New York, 1952: 190 pp., 2 figs., 69 pls. (40 in color), 7 photos. $3.50.—This well prepared handbook is similar in format and purpose to the author's earlier *North American Game Fishes*, and incorporates 47 illustrations from that volume. It presents a cross section of salt-water game fishing and fishes around the world, with official catch records as recognized by the International Game Fish Association. Altogether, 138 species are illustrated by Janet Roemhild. For each species is given the common name(s), distribution, color, distinguishing characters, size, food, habits, angling value and commercial use. A short, alphabetically arranged geographical section describes fishing grounds, seasons and facilities, and is followed by an index to common and scientific names. On the whole, the color plates and black and white illustrations are very good. I note an error in the identification as the margate grunt (Pl. 43) of the pompon, *Anisotremus surinamensis*. This book is a guide for anglers, and a very worthwhile one.—ROBERT RUSH MILLER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

THE BOOK OF FISHES. Edited by John Oliver La Gorce. National Geographic Society, Washington 6, D. C., Rev. Ed., 1952: xii + 339 pp., 170 black and white illus., 206 color pls. $6.50.—This is a worthy successor to the popular 1939 edition, to which have been added some 91 color plates, a host of new photographs, and 7 new articles (15 in all). Eight chapters are by the same authors as in the earlier edition, but have been mostly rewritten, and 3 of the earlier articles have been dropped. The type bed is somewhat wider so that the total pagination (but not words) is reduced, making the volume less bulky than before. It is attractively cloth-bound and beautifully printed, with excellent black and white illustrations and some remarkable color photographs. The term fishes is used in the broad sense to include many small and large marine animals. This is an ideal book for the young to old fisherman and naturalist, for whom it is intended. It is non-technical yet

authoritative, and the illustrations alone are worth the price of the volume.—ROBERT RUSH MILLER.

ZOOLOGICL RECORD. Vol. 88, Sec. 15 (Pisces), Sec. 16 (Amphibia and Reptilia), containing literature references for 1951. 1953.—The section on Pisces lists 1,088 titles; that on Amphibia and Reptilia, 1,233 titles. Prices of the two sections as separates are, respectively, 7s and 7s 6d, postage extra. Orders should be sent to the Director, Zoological Society of London, Regent's Park, London, N. W. 1, England.

EDITORIAL NOTES AND NEWS

Louis A. Lantz LOUIS AMÉDÉE LANTZ died in Switzerland on February 3, 1953, at the age of sixty-six, and herpetology has lost one of its outstanding figures. A chemist by profession, LANTZ was an amateur of herpetology in the true sense of the word. Seeking relief from the mechanical precision of the physical sciences in the less predictable behavior of living organisms, he brought to his hobby the trained, restless mind of the true scientific investigator.

Born and educated in Alsace, his first appointment, after graduation and a two years apprenticeship in cotton dyeing and printing, was as a research chemist in an industrial laboratory in Moscow. Here he spent 10 years, until the revolution of 1918 drove him from the country, and it was here that the pattern of his herpetological life developed. Summer vacations were spent in the Caucasian region, observing and making collections of preserved specimens for a series of systematic and faunistic works, and of living amphibia for subsequent study in the vivarium. During most of the rest of his life, when he was director of the Calico Printers' research laboratory in Manchester, the same pattern continued except that his collecting ground shifted to the Mediterranean littoral and Pyrenean region.

Important though his systematic work is, and without it the Caucasian lizard fauna would still be but sketchily known, his greatest contributions to zoology probably sprang from his skill in aquarium and vivarium techniques.

He was able to get many palaearctic amphibians not only to breed regularly but to hybridize, and in some instances the hybrids were maintained for generation after generation and back crossed with the parental stocks to provide a mass of valuable genetical information, some of it still unpublished.

Despite long expatriation and a profound belief in international cooperation, LOUIS LANTZ remained devoted to his native France and had intended to spend his years of retirement working at the Muséum d'Histoire Naturelle. Much though herpetology has lost through the failure of this project, the large circle of his friends has lost even more; they have lost a man on whose character, judgement and succour they could rely unfailingly. —H. W. PARKER, *British Museum (Natural History), Cromwell Road, London, SW 7, England.*

Bishop Reprints DR. WILLIAM E. FAHY advises that he has a limited supply of reprints of several papers by the late SHERMAN C. BISHOP, for free distribution upon request. The available papers are: (1) The toad. Univ. State of N. Y. Leaflet, 2 pp., 1924; (2) An older name for a recently described salamander. COPEIA, 1942 (4): 256; (3) A new neotenic plethodont salamander, etc. COPEIA 1944 (1): 1–5; (4) The identity of *Siren Harlanii* and *Axolotes maculata*. Herpetologica, 1945, p. 24; (5) Book reviews of Amphibians and reptiles of Chicago area by Pope, and of Reptiles and amphibians of Minnesota by Breckenridge. Ward's Nat. Sci. Bull., 18 (3); 1 p.; (6) An alleged new species of muskellunge. COPEIA, 1946 (1): 43; (7) Reversal in the winter flounder. Science, 103 (2667): 174–5; (8) Supposed cases of mimicry in salamanders. Herpetologica, 1947, p. 178; and (9) Response of minnows to earth vibrations. COPEIA, 1950 (4): 318. Copies can be obtained by writing to DR. FAHY, Institute of Fisheries Research, University of North Carolina, Morehead City, N. C.

Stanford News REFITTING of the main fish collection storage room at the Natural History Museum of Stanford University with new steel shelving is actively progressing (as of September, 1953). All fish bottles and crocks have been removed and stored tempo-

rarily in other parts of the building. The 9,000 square feet of new shelving will increase fish-specimen storage facilities by two-thirds. In addition, it is hoped to utilize part of the old shelving to increase hepetological storage space by from 50 to 100 percent. The entire project is costing about $30,000, nearly $28,000 of which has already been raised by the graduate students' Zoology Project Fund Committee, headed by GILES W. MEAD, JOHN C. BRIGGS, and JAY M. SAVAGE. Gifts also have been received from the Museum's many alumni and friends. MR. SAVAGE is directing the student crews working on the project.

PROFESSOR D. L. WOHLSCHLAG of Stanford has been completing research projects on the sampling of fish populations in California fresh waters, done with the cooperation of the California Department of Fish and Game, and on population characteristics of whitefishes near Point Barrow, Alaska, on which he worked at the Office of Naval Research Arctic Research Laboratory at Point Barrow. PROFESSOR MYERS has been continuing work on characids, echeneids, and zeomorphs. DR. JOHN C. BRIGGS, who is completing his world monograph of the fishes of the family Gobiesocidae, has been appointed Research Associated in Ichthyology for the academic year, 1953–54. MISS MARGARET STOREY, Assistant Curator of Zoological Collections, has been actively supervising the Zoology Project.

Among graduate students working for the doctorate at Stanford are: JAMES E. BÖHLKE (review of "cheirodontine" characids), DANIEL M. COHEN (systematic ichthyology), H. A. FEHLMANN (revision of emblemariid blennies), N. J. WILIMOVSKY (ichthyofauna of the Arctic Ocean), FRANK S. CLIFF (herpetofauna of the islands of the Gulf of California), ALAN E. LEVITON (revision of *Maticora* and general studies of Philippine reptiles), and JAY M. SAVAGE (systematics and osteology of Xantusiidae). Students who have recently received the doctorate are: DR. GILES W. MEAD (pelagic feeding habits of fur-seals off Japan, with studies on the deep-sea fishes involved), and DR. J. P. WELSH (population studies on Yellowstone trout).

Students who have recently received the masters' degree: A. E. LEVITON (review of Philippine snakes of the genus *Oligodon*), ANN B. FUNKHOUSER (revision of the frogs of the genus *Phyllomedusa*), D. M. COHEN (growth of Alaskan whitefishes), and CHARLES VON GELDERN (partial bibliography of fish diseases).

Among resident researchers at Stanford recently have been: DR. L. S. RAMASWAMI of Mysore University, Mysore, India, who completed a study of the osteology of gobionine Cyprinidae; SR. ANTENOR LEITAO DE CARVALHO of the Museu Nacional, Rio de Janeiro, who substantially completed a beautifully illustrated monograph of South American microhylid frogs; DR. WALTER C. BROWN, who is revising several groups of Pacific Islands Scincidae; and DR. MARY CHANDY of Delhi University, Delhi, India, who is revising the Asiatic Ophiocephalidae.

All fish types in the Stanford collection have been checked over and listed by J. E. BÖHLKE, and the extensive list of them has recently been published in the Stanford Ichthyological Bulletin. A list of types of reptiles and amphibians at Stanford has been published by A. E. LEVITON, who has also collaborated with J. R. SLEVIN in preparing a list of herpetological types in the California Academy of Sciences (now in press).

N. J. WILIMOVSKY's studies of the fishes of the Arctic Basin have been carried on for the third year under the Office of Naval Research. In the summer of 1953 a vessel for collecting the deeper-water fishes was available and many new records were obtained. Another Stanford project of 1953 was a second cruise in the Gulf of California aboard the ORCA at the invitation of her owner, J. W. SEFTON, JR., of San Diego. DR. BRIGGS and MESSRS. CLIFF and LEVITON participated, and large fish and reptile collections were obtained.

Among the students beginning graduate work at Stanford in 1953 are OTTO M. SOKOL in herpetology, STANLEY H. WEITSMANN, who will work on characid osteology, and BENJAMIN H. BANTA.

University of Texas

WILLIAM W. MILSTEAD completed the Ph.D. at the University of Texas in May, 1953. His thesis is entitled "Competition and other interrelationships in natural populations of racerunners (genus *Cnemidophorus*)." He is currently teaching herpetology and ecology in the Faculdade de Filosofia, Universidade do Rio Grande do Sul, Porte Alegre, Brasil. WILMOT A. THORNTON completed the Ph.D. in July, 1953. His thesis is on "Population relations and isolation mechanisms in *Bufo woodhousei* and *Bufo valliceps*." He is currently Instructor in Zoology and Research Scientist on an Atomic Energy Commission project at the University of Texas.

Current doctoral research on the cold-blooded vertebrates at the University of Texas includes: KIRK STRAWN, "Effects of temperature on the meristic characters of several populations of the greenthroat darter, *Etheostoma lepidum*"; HILMI SABER AL-UTHMAN, "The classification and anatomy of the blennioid fishes of the tribe Starksiidi"; HAGUE L. LINDSAY, "Factors affecting gene exchange in the *Pseudacris nigrita* complex in Texas"; WILLIAM R. MEACHAM, "Factors affecting gene exchange between the allopatric toad populations, *Bufo woodhousei* and *B. fowleri*"; JOHN S. MECHAM, "Ecological zoogeography of the reptiles and am-

phibians of the Guadalupe Mountains of New Mexico and Texas"; DAVID PETTUS, "An analysis of relationships between natural populations of *Natrix s. confluens* and *N. s. clarki*"; WILLIAM F. PYBURN, "Geographic differentiation in relation to population structure and pattern of distribution in cricket frogs (*Acris*)"; AARON O. WASSERMAN, "Factors affecting interbreeding of allopatric and sympatric populations of spadefoot toads (genus *Scaphiopus*)."

Texas Herpetological Society The Texas Herpetological Society held its annual field meet near Madisonville, Texas on May 2 and 3, 1953, with 47 collectors registered. The Society, as usual, made lengthy previous arrangements with local people for permission to collect in a large area surrounding the base camp which was set up near the town of Midway. Although all reports of collections made on the trip are not yet available, the reports compiled to this date include over 40 species and subspecies of amphibians and reptiles, representing 30 genera. New Society officers elected are WERNER GOTTSCH (University of Houston), President; RALPH AXTELL (University of Texas), Vice President; RICHARD J. BALDAUF (Agricultural and Mechanical College of Texas), Secretary; JOHN W. FORSYTH (Texas Christian University) and LAWRENCE CURTIS (Dallas Zoo), Executive Board.—RICHARD J. BALDAUF.

Mailing dates Copeia, 1953 COPEIA for 1953 was postmarked at Baltimore, Maryland on the following dates: No. 1 on March 21, No. 2 on June 1, No. 3 on August 28, and No. 4 (mailed but not postmarked) on November 27.

News Notes LESLIE W. SCATTERGOOD has been given a leave of absence by the U. S. Fish and Wildlife Service to accept a Fulbright research grant for a study of the methods of fishery investigation in Norway. His address for the academic year 1953–54 is Fiskeridirektoratets Havforskningsinstitutt, Bergen, Norway.

At the annual meetings of the American Fisheries Society in Milwaukee on September 17, 1953, DR. R. W. ESCHMEYER received the National Award for Literature for 1953 given by the National Association of Conservation Education and Publicity, for his series of booklets (Fisherman Press, Inc.) on life histories and conservation of wildlife species. The series comprises 10 numbers, to date, including *Al Alligator* and three species of fish (reviewed in COPEIA, 1952 (3): 214). DR. ESCHMEYER advises that these booklets are intended for readers at the 12-year level, and that a continuation of the series is planned for the near future.

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